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31 May 1956

Report No. 1106

(Final) Volume II

Copy No. _____

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RESEARCH, DEVELOPMENT,
AND TESTING OF
UNDERWATER
PROPULSION DEVICES



Contract N6ori-10, Task Order I
Project NR 097 003

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31 May 1956

Report No. 1106
(Final)
Volume II

RESEARCH, DEVELOPMENT, AND TESTING OF UNDERWATER PROPULSION DEVICES

Contract M60ri-10
Task Order I
Project NR 097 003

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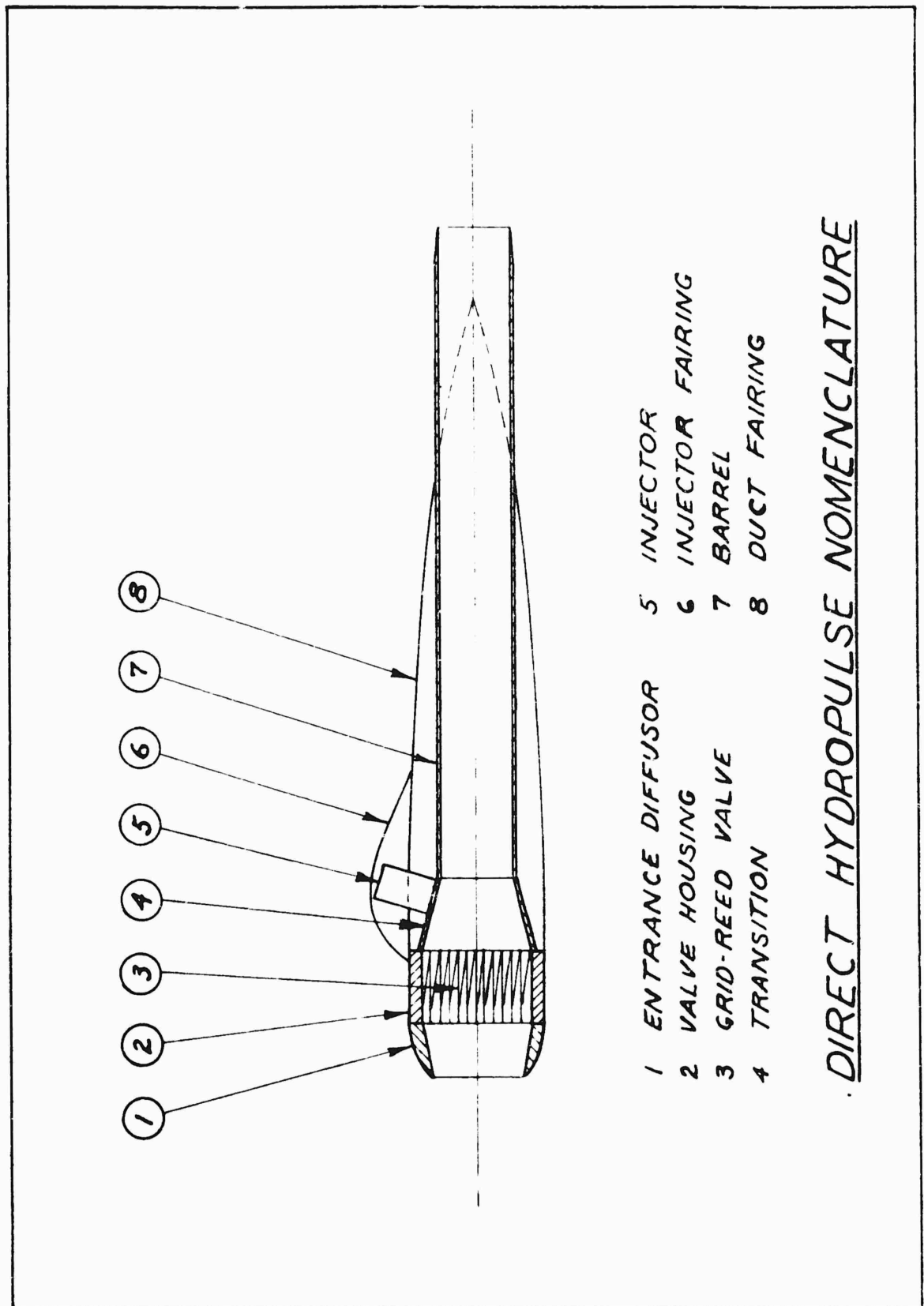
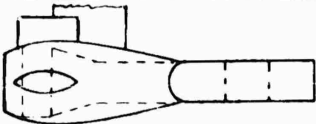
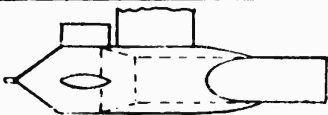


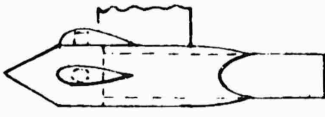

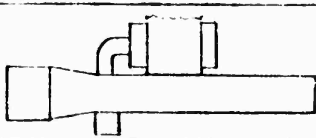


Figure 1

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Chart of Hydropulse Motor Models

UNIT NO.	SKETCH	INJ./BBL.	BARREL SIZE	DATE 1 ST RUN	REMARKS
1		1 & 2	4"X60" TO 4"X18"	9-13-45	SQUARE FACED FRONT ENTRY
2	SAME AS #1	1 & 2	4"X30" 4"X24"	1-14-46	
3	SAME AS #1	2 & 3	4"X30"	2-6-46	
4	SAME AS #1				
5	SAME AS #1	2	4"X36"	3-28-46	
6		2	4"X30" 4"X36"	4-12-46	SLANT VALVE
7	SAME AS #6	2	4"X30" 4"X36"	5-6-46	
8		1 & 2	4"X36"	8-9-46	SQ. FACED FRONT ENTRY— ALSO USED WITH ETHIDE
9	SAME AS #8	1 & 2	4"X48"	8-29-46	
10	SAME AS #8	1	3"X42"	10-8-46	
SEHP MK I		1	#1 3"X36" #2 3"X36" #3 3"X30"	11-26-46 1-3-47	4 BARREL SIDE ENTRY
11		2	4"X36"	12-12-46	HIGH PRESSURE SLANT VALVE
12		1	4"X36"		USED FOR MOLTEN Li
13		1	4"X36"	12-20-46	USED FOR MOLTEN Li





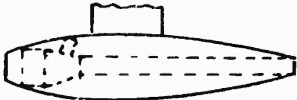



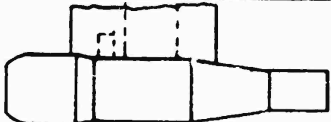
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Figure 2

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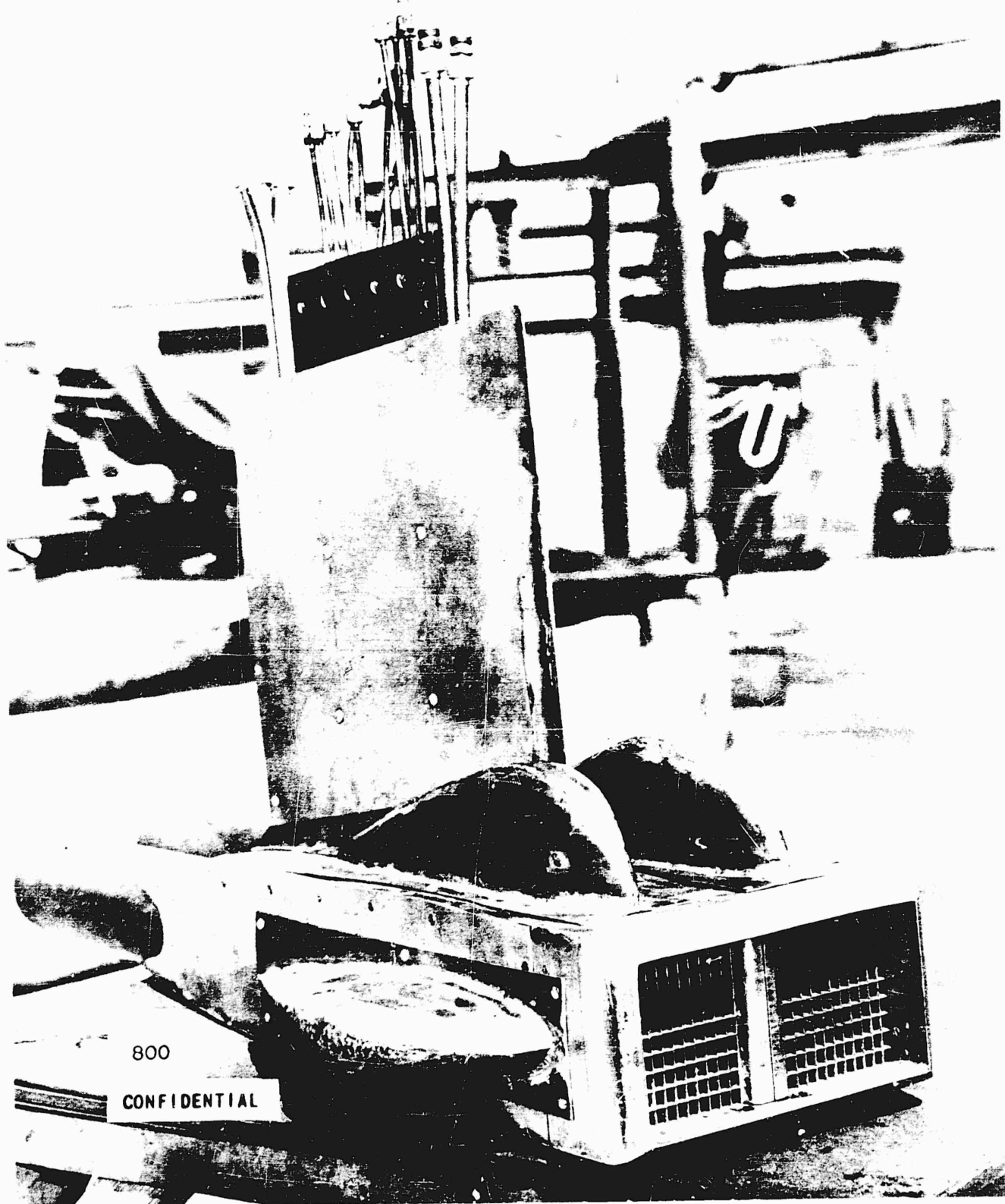
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Chart of Hydropulse Motor Models (Cont.)

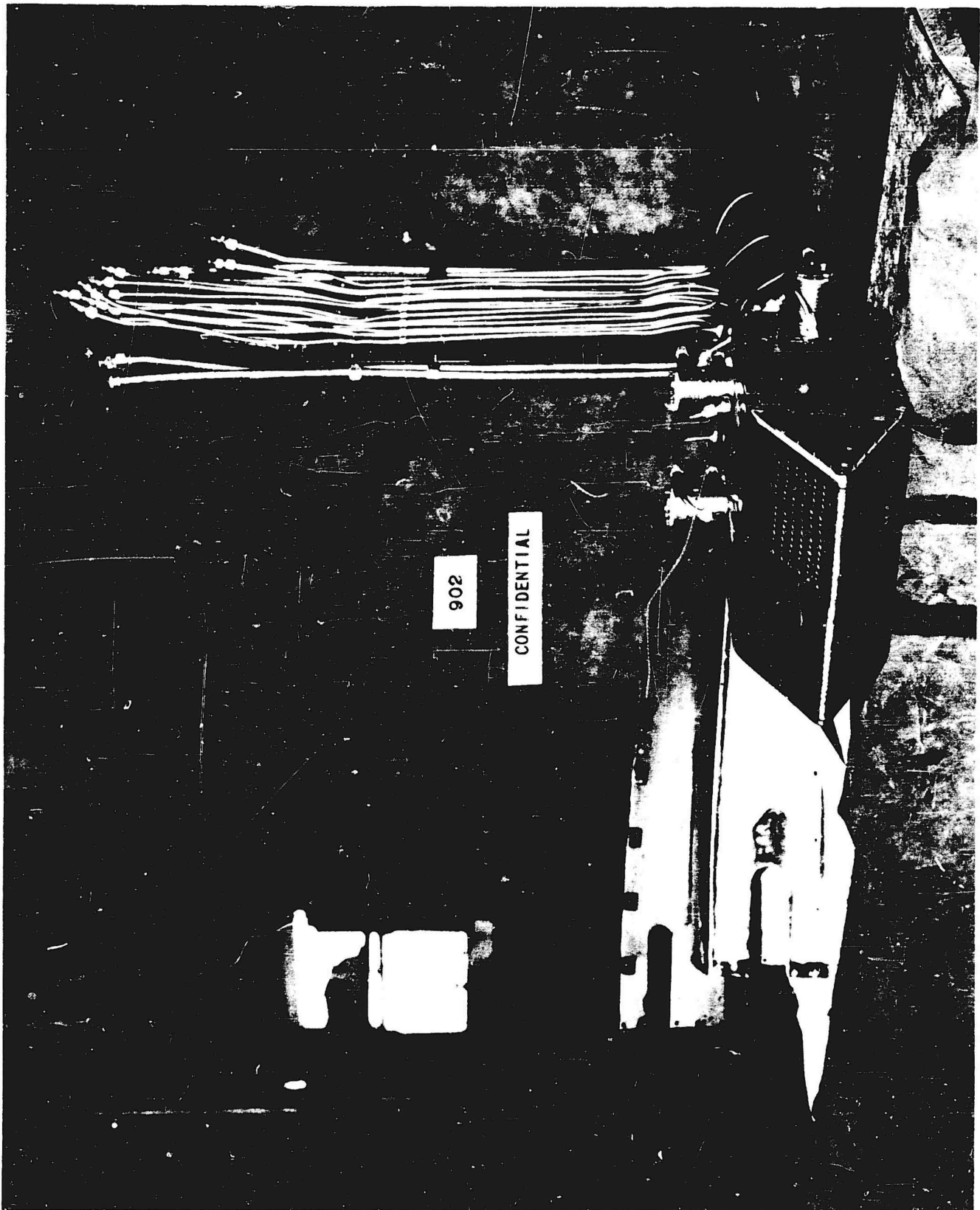
UNIT NO.	SKETCH	INJ./BBL.	BARREL SIZE	DATE 1ST RUN	REMARKS
14	SAME AS #13	1	4"x36"		USED FOR MOLTEN LI
15		2	4"x48"	3-13-47	INVERTED HYDROPULSE-SOLID SODIUM
16	SAME AS #15	2	4"x48"		
17		1	4"x36"	3-14-47	MULTI-BALL ENTRY VALVE
18		1	4"x36"	4-17-47	CONICAL SPRING ENTRY VALVE
SEHP MK II		1	3"x36" 3"x30"	4-14-47 9-3-47	4 BARREL SIDE ENTRY MARK II
19		1	6"x75"		SINGLE BARREL FRONT ENTRY TORPEDO FOR LI
20	SAME AS #8	1	4"x48"	9-12-47	
21		1	4"x48"	7-22-47	SINGLE BARREL-TO TEST SELF CYCLING INJ.
22		1	4"x48" 4"x42"	1-15-48	SINGLE BARREL-BUILT UP FOR MOLTEN LI
23		1	4 x 36	1-21-47	ENLARGED DUCT BETWEEN VALVE AND TAIL PIPE
24		1	4x36	12-9-47	GAH-30 CONVERTED FOR USE WITH ALLOY

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Figure 3



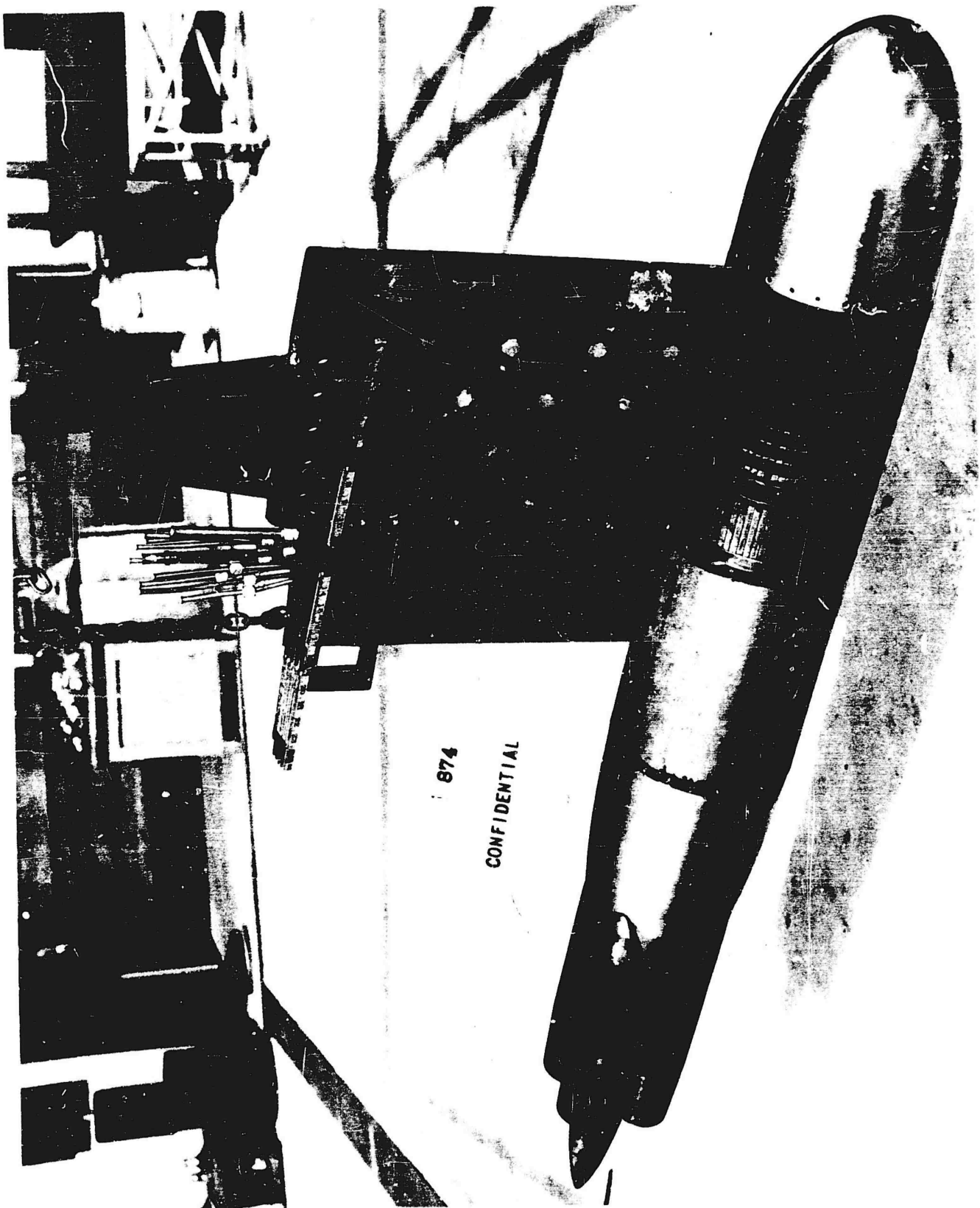
Twin-Barrel Hydropulse Showing Operating Tubing and Injector Housing



Twin Hydropulse with Fairing Removed, Showing Slant Valve and Injectors

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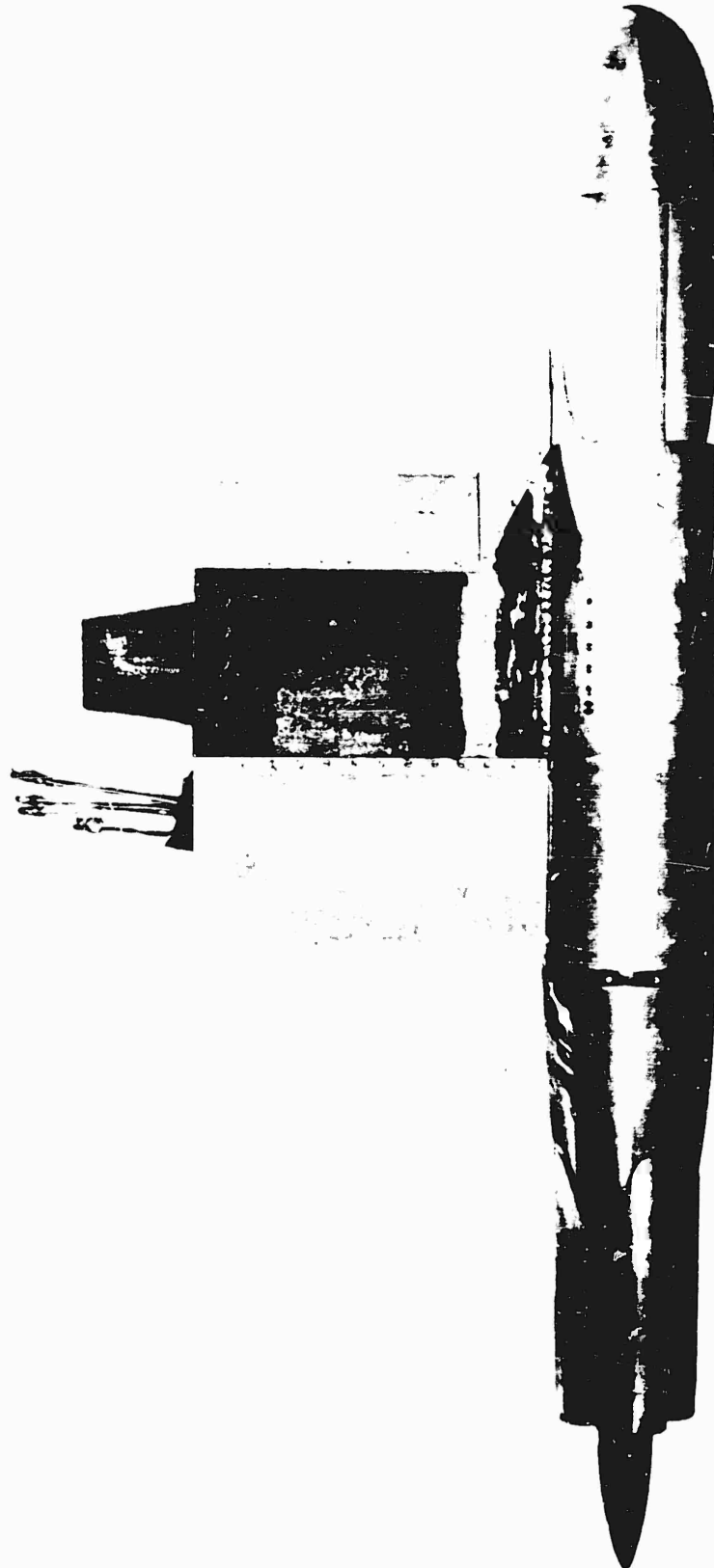
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Streamlined Side-Entrance Hydropulse, Four Barrels, 3-in.-dia

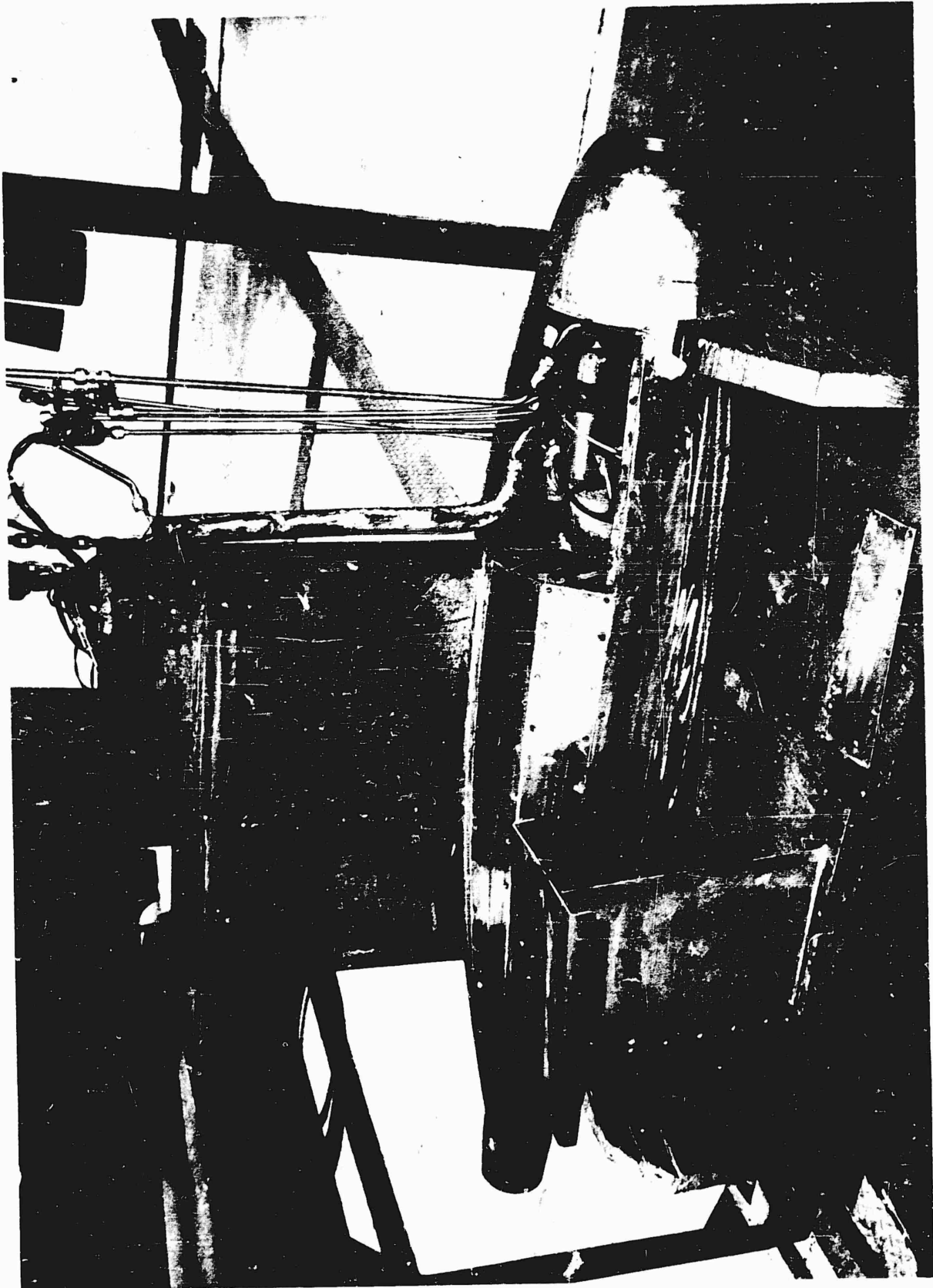
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Figure 6



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Streamlined Side-Entrance Hydropulse, Mark II, Four Barrels, 3-in.-dia



Unit 26 with Hatch Removed to Show Injector, Type 27, in Place

R749-1

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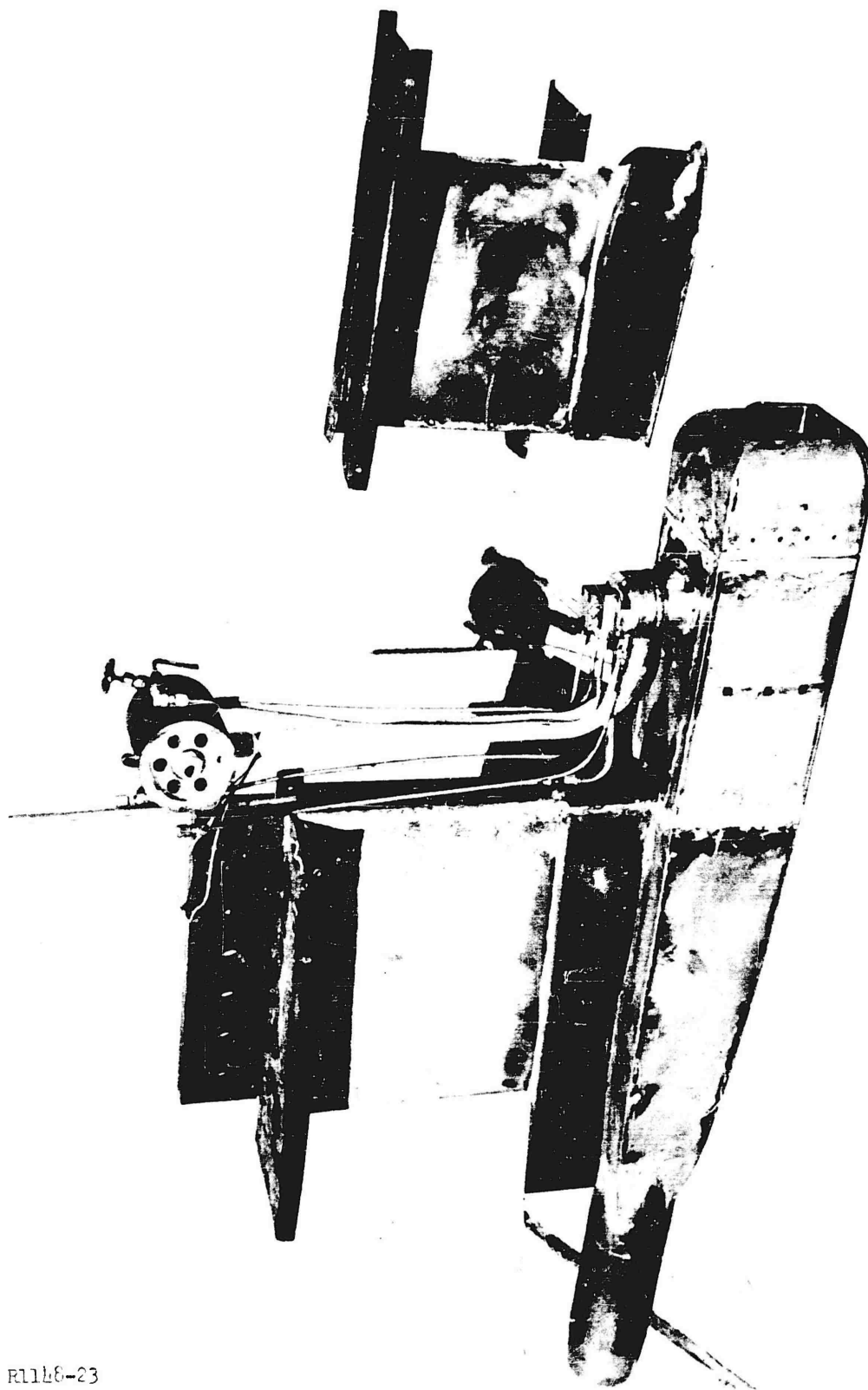
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Hydropulse Unit 22-A, Showing Type-22-Injector Plumbing Details

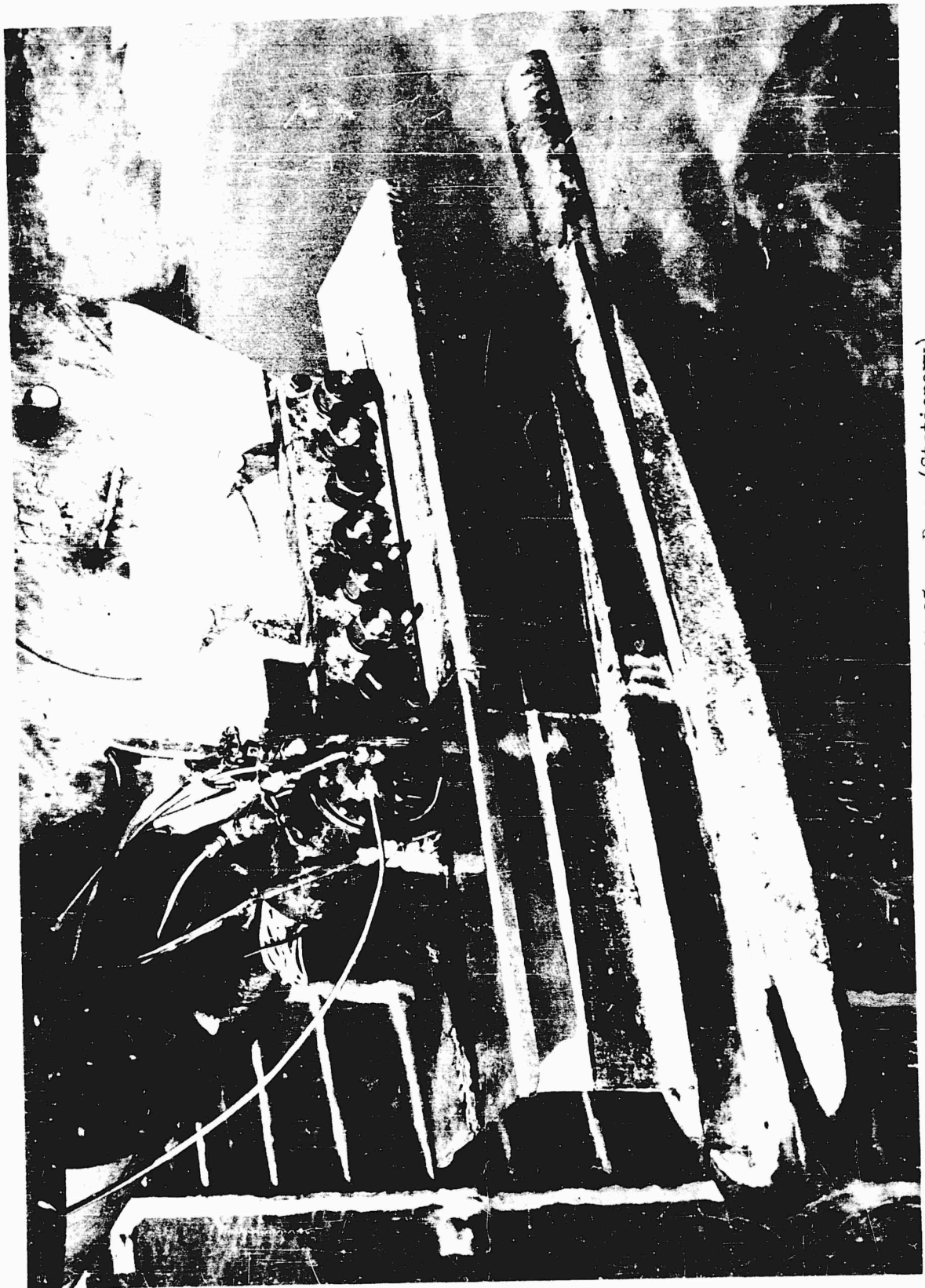
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Figure 9

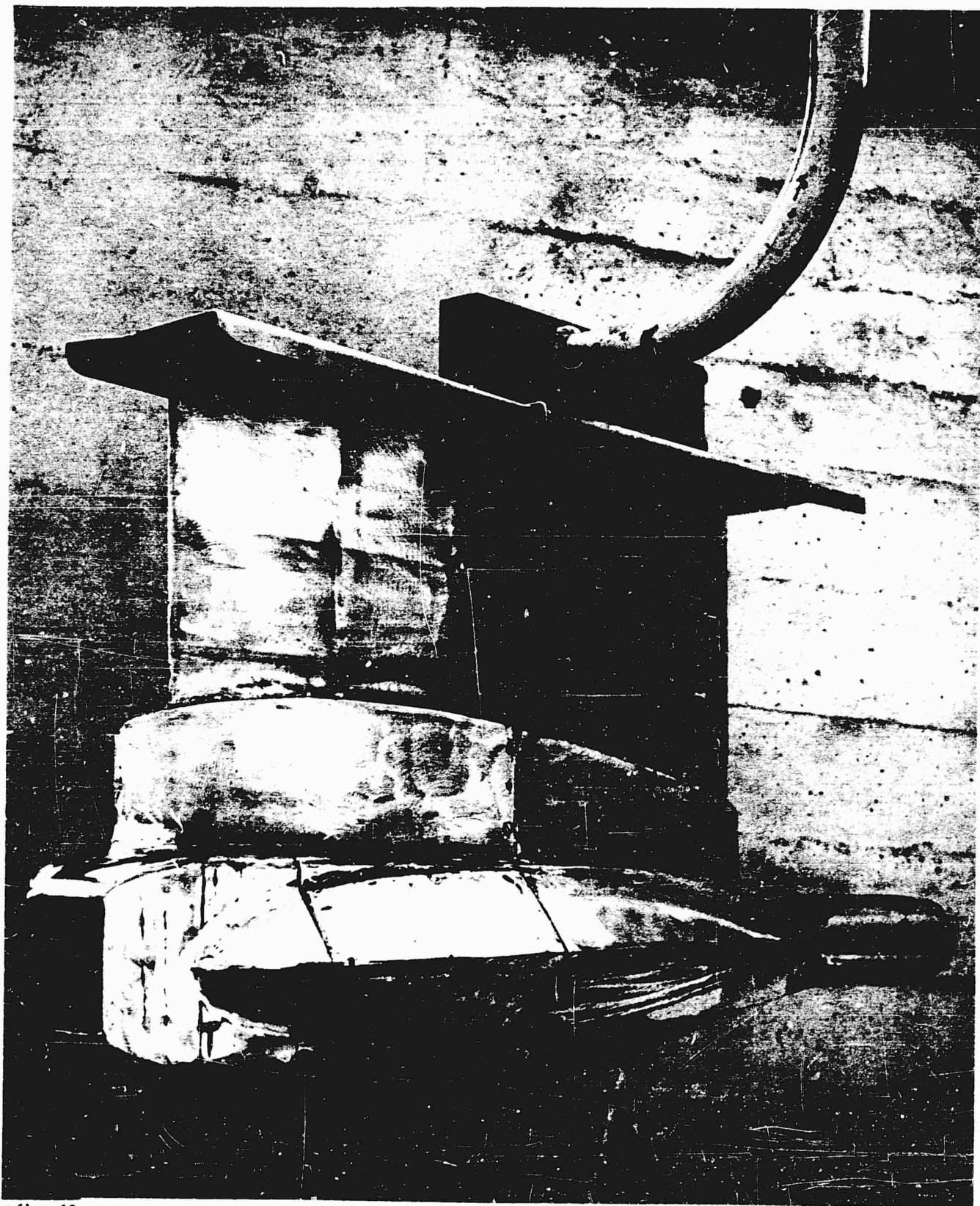


Unit 22-D with Forward Fairing Removed, to expose the Lithium System

R1118-23

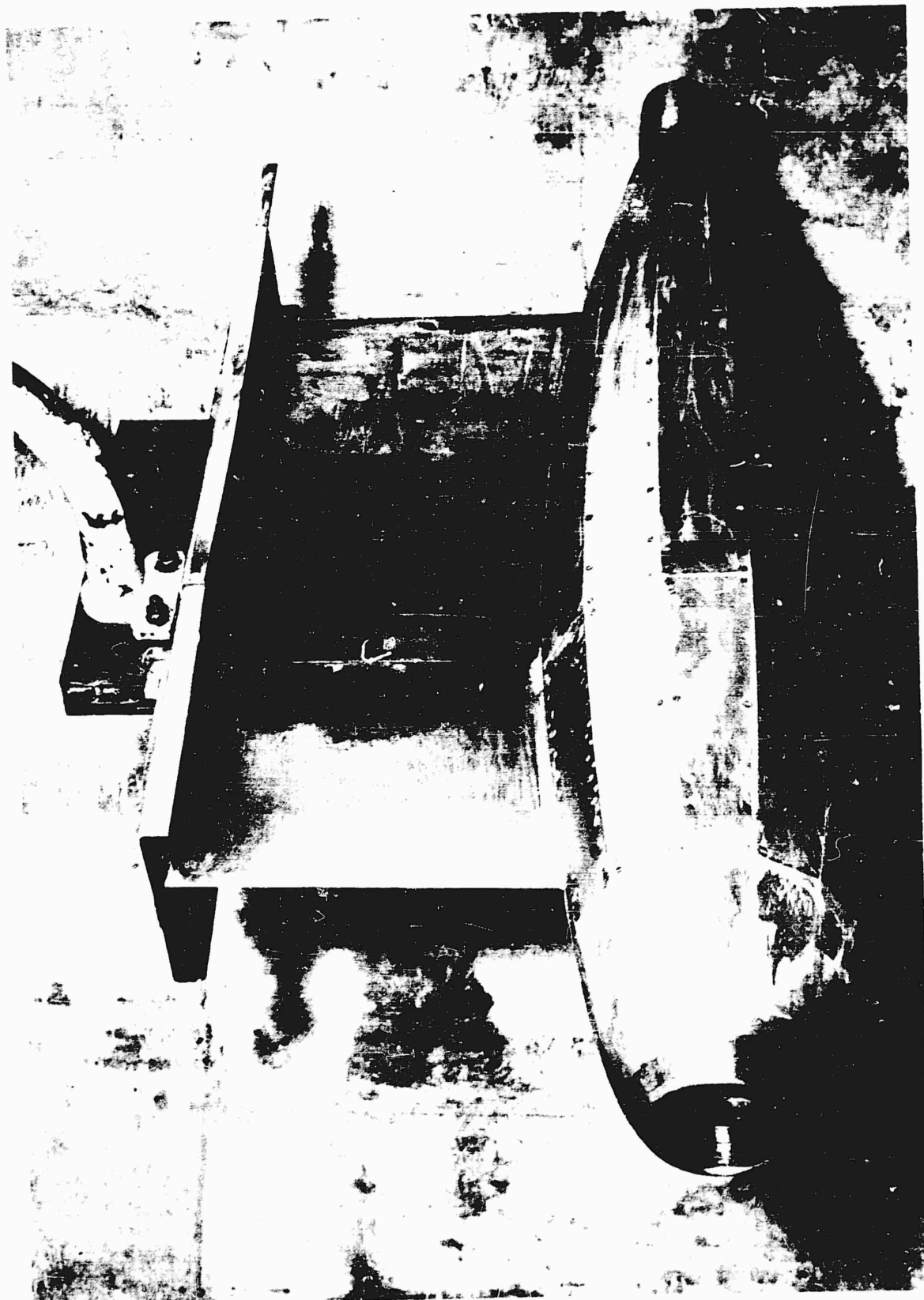


Direct Hydropulse Unit 25 on Boom (Stationary)



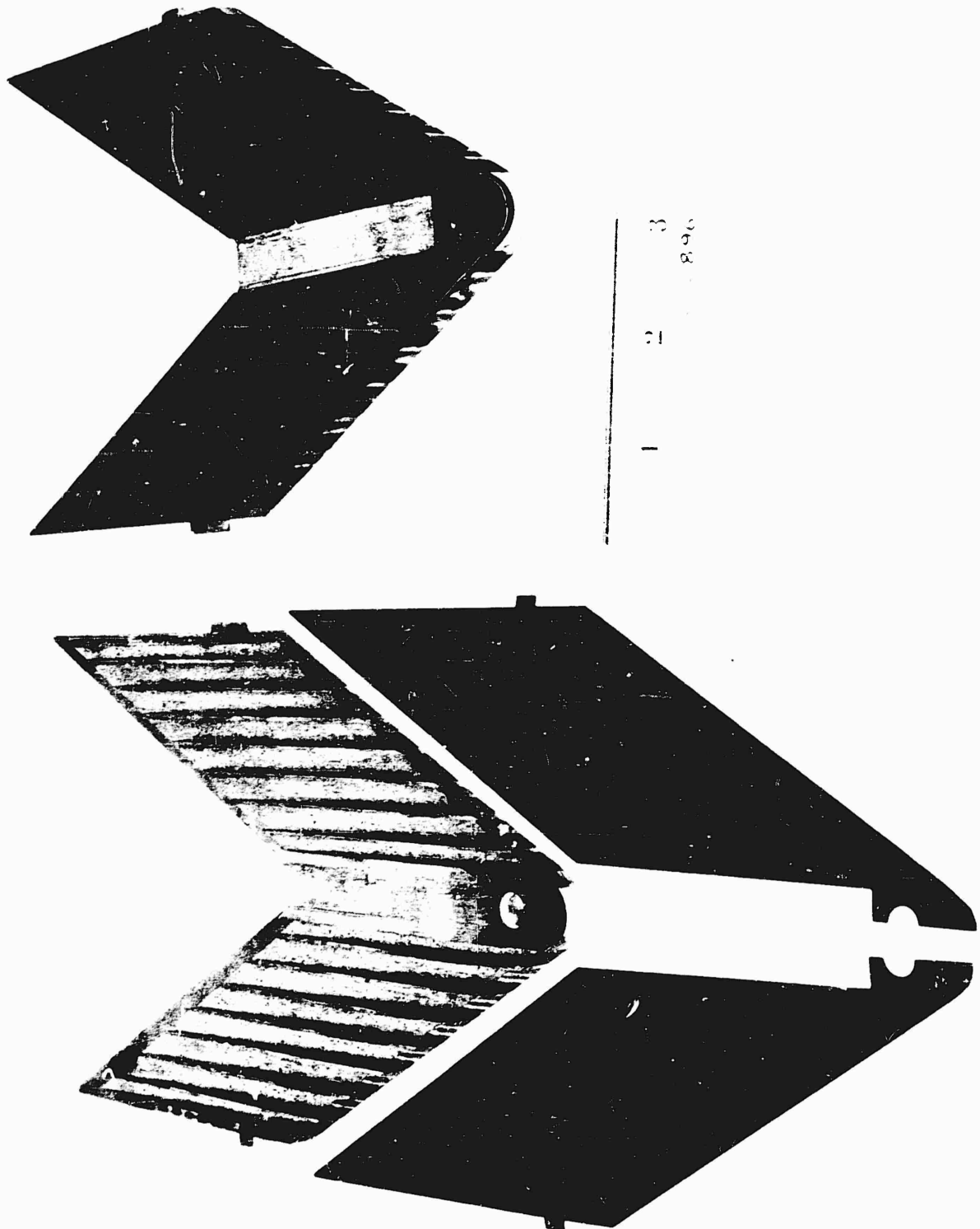
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Direct Hydropulse Unit 25, 3/4 View



Unit 26, A Direct Hydropulse with a 2/3 Scale, Mark-40 Profile

REF-100



Typical Valve Grid and Reed Arrangement

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Details of Entrance Valves and Barrel Arrangement for Streamlined Side Entrance Hydropulse

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Figure 15

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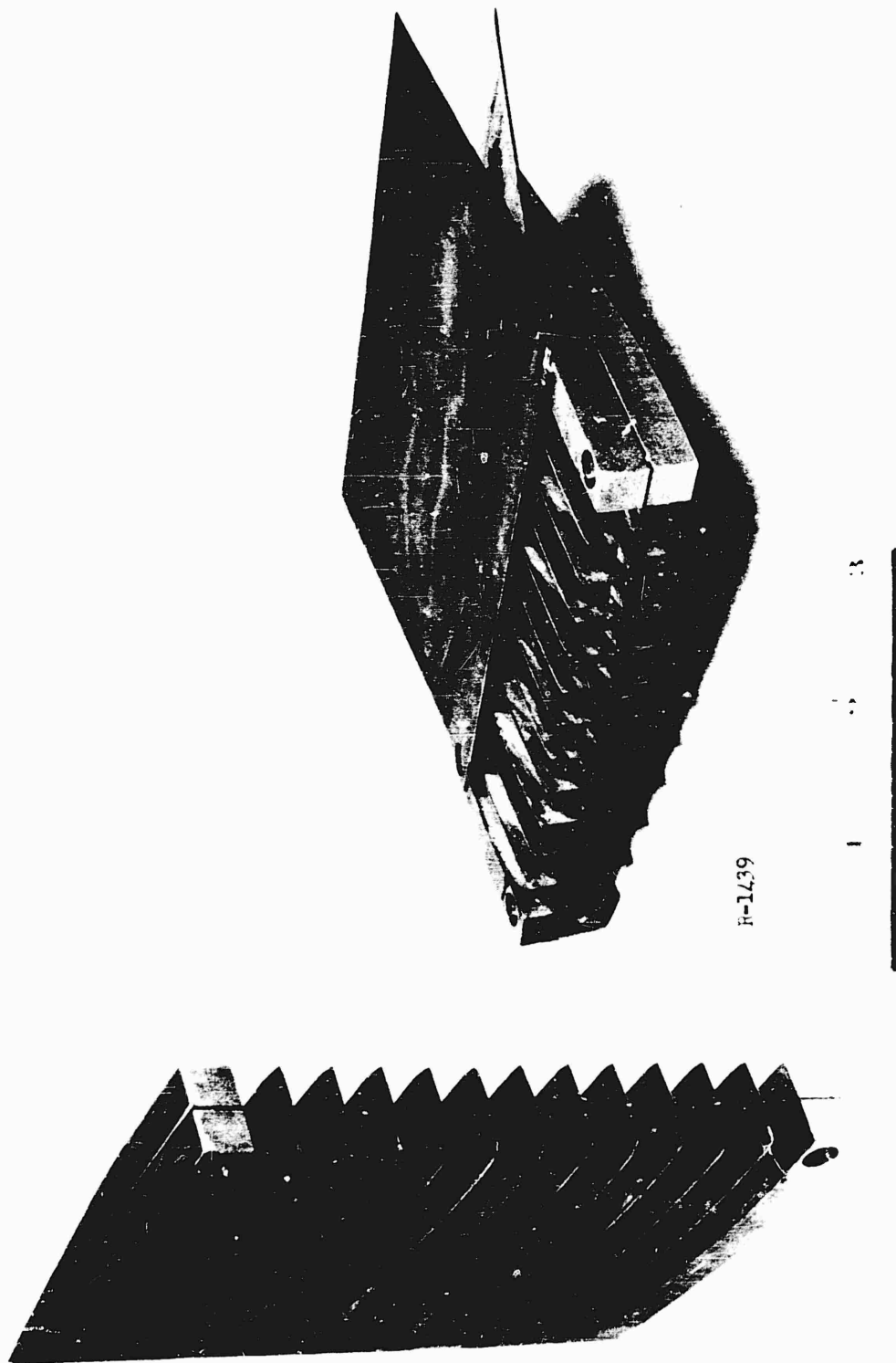
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Detail of Reed-Grid Type Entrance Valve of the Side Entrance Hydropulse, Mark II

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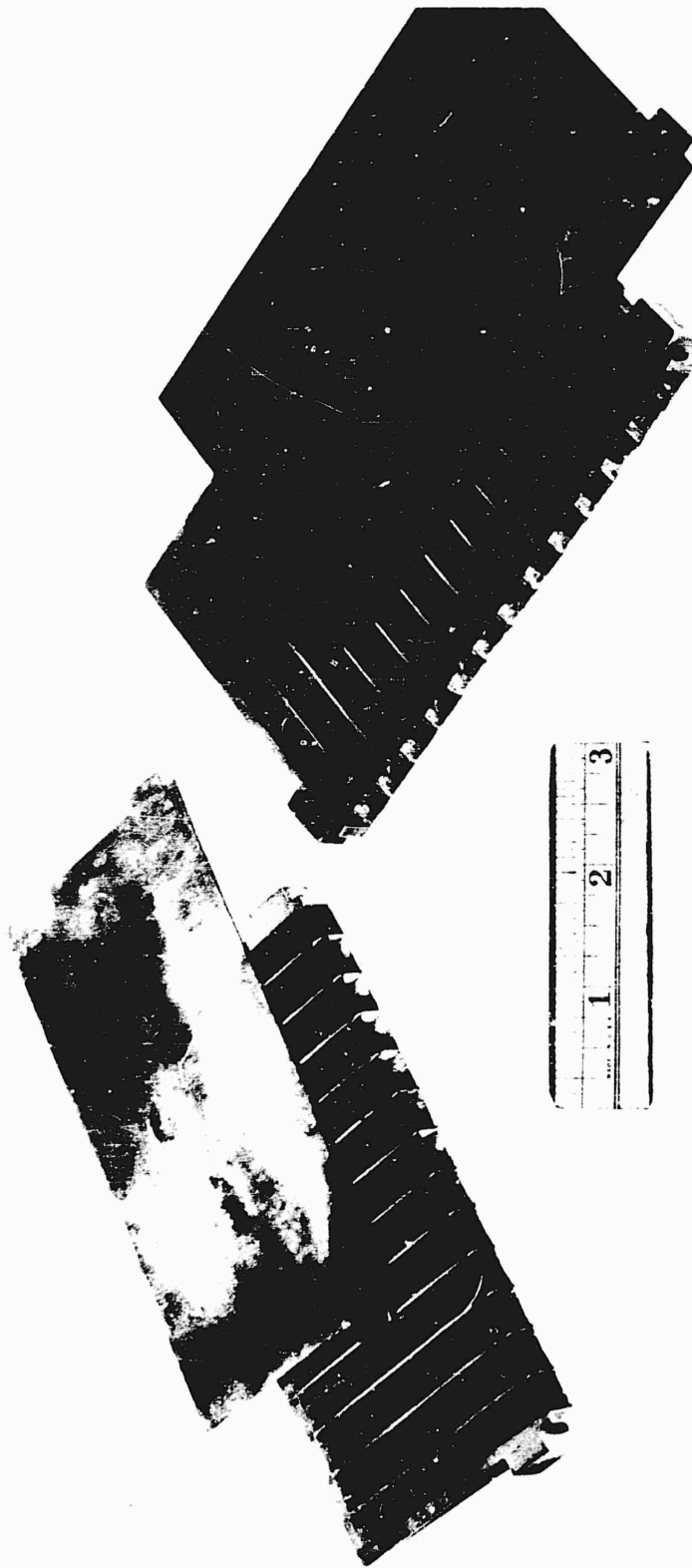
Figure 16



Improved Double-Sided Grids with Flexure Curve Profile

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Report No. 1106





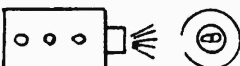

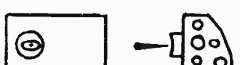









Grids and Reeds for the Shortened Water-Entrance Valve

R649-66

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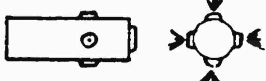







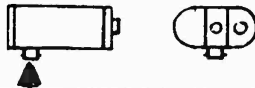

Figure 18

CHART OF INJECTOR TYPES

TYPE	PART NO	PHYSICAL CHARACTERISTICS	
1	AR4015		CWS* - ONE LATER MODEL MADE WATERLESS (4042)
2	AR4054		IWS**
3	AR4071		DOUBLE IWS - LATER USED AS CWS
4	AR4199		4-a SLOT 4-b SPIRAL PINTLE 4-c EEBW "SPRAYCO" STRUT 4-d E5 "SPRAYCO" STRUT
5	AR4160		CWS FOR SEHP MK I
6	AR4296		WATERLESS SLOTTED STRUT TYPE FOR SEHP MK I
7	AR4180		ACTUATOR ONLY FOR VALV- ING LITHIUM
8	AR4279		WATERLESS SLOTTED - SINGLE INJ. SERVICES 4 BARRELS
9	AR4045		IWS WITH SPRING DOME LOADING ON PINTLES
10	AR4294		WATERLESS - CONICAL SPRAY SPIRAL PINTLE IN #3 INJ. BODY
11	AR4361		SHORT BODY - WATERLESS SPIRAL PINTLE
12	AR4349		WATERLESS - CONICAL SPRAY SPIRAL PASSAGES
13	AR4344		SELF CYCLING INJ OPERATED BY MOTOR BARREL PRESSURE
14	AR4510		HEATED - BELLOWS TYPE SEAL - USED FOR MOLTEN LI

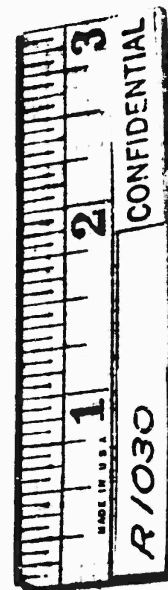
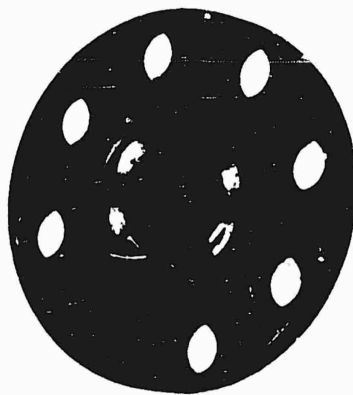
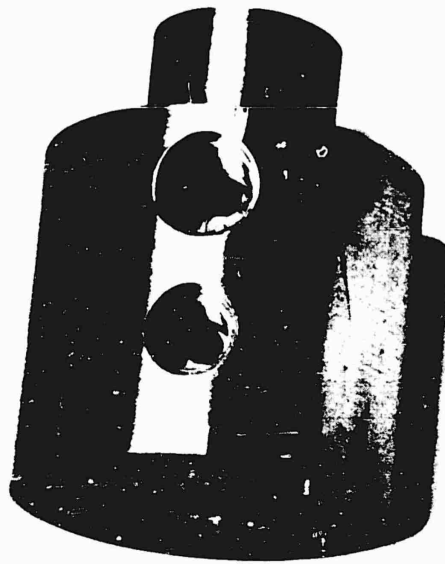
*CONTINUOUS WATER SQUIRT **INTERRUPTED WATER SQUIRT

CHART OF INJECTOR TYPES (CONTINUED)

TYPE	PART NO.	PHYSICAL CHARACTERISTICS	
15	AR 4586		EXTRA HIGH CAPACITY - 2 FUEL INLETS - "SPRAYCO" NOZZLE
16	AR 4410		SELF CYCLING INJ. FOR 4 BARRELED MOTOR
17	AR 4570		WATER METERED SELF CYCLING INJ.
18	AR 4532		OIL METERED SELF CYCLING INJ.
19	AR 4669		FUEL METERED SELF CYCLING INJECTOR
20	AR 4719		WATER METERED SELF CYCLER WITH AUX. FUEL SHUTOFF PINTLE
21	AR 4734		WATER METERED SELF CYCLER - BALL CHECK - CENTER SPRAY
22	AR 4780		A REVISION OF TYPE 14 - ALL TUBE CONNECTIONS FACE AFT.
23	AR 4790		"CHATTERING" PINTLE INJECTOR - SELF CYCLING - ALLOY
24	AR 4700		LITHIUM CHATTERING SELF CYCLER - BELLOWS ACCUMULATOR ENCLOSED
25	AR 4700		CHATTERING SELF CYCLER FOR MOLTEN LITHIUM

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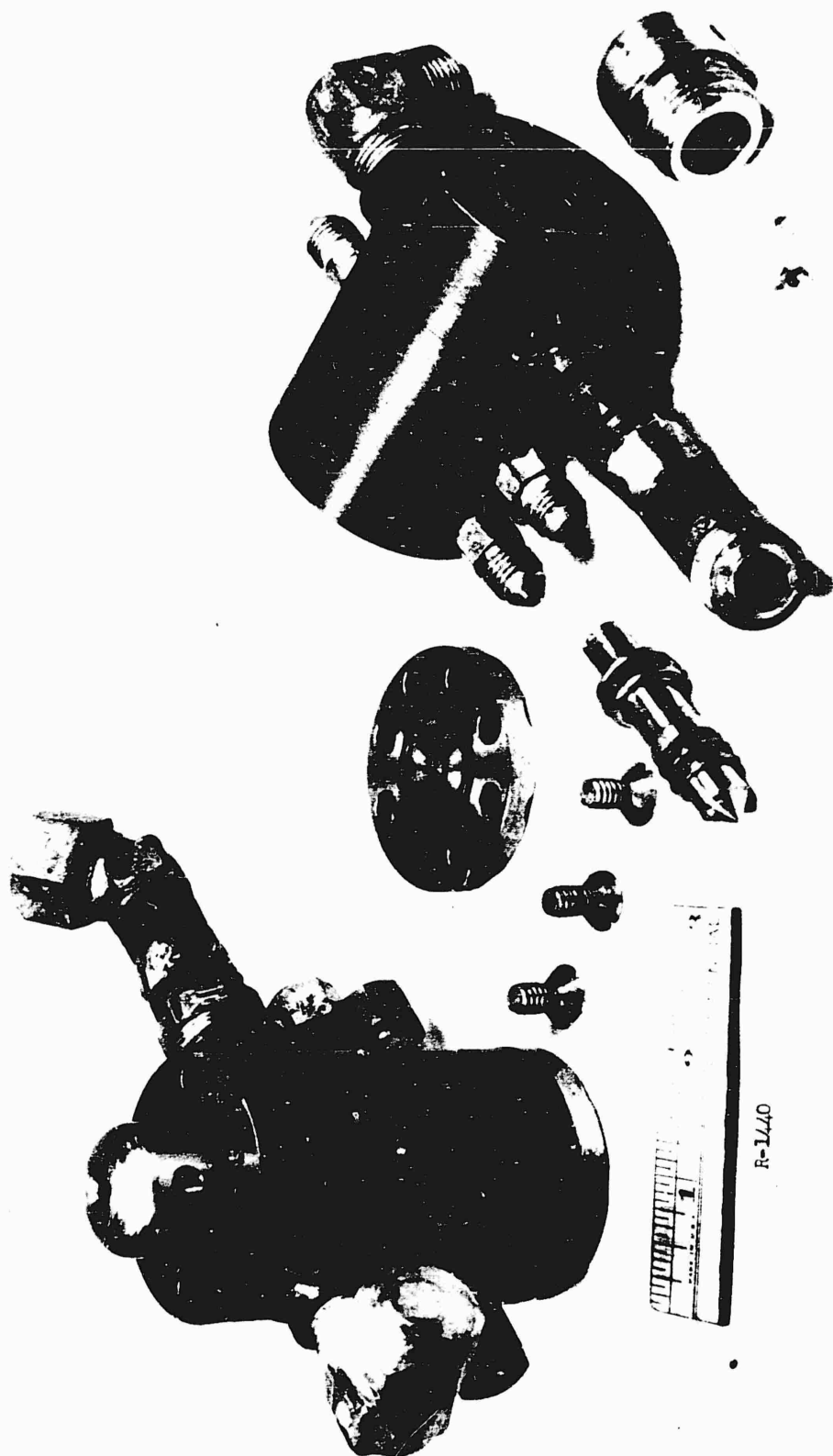
Report No. 1106



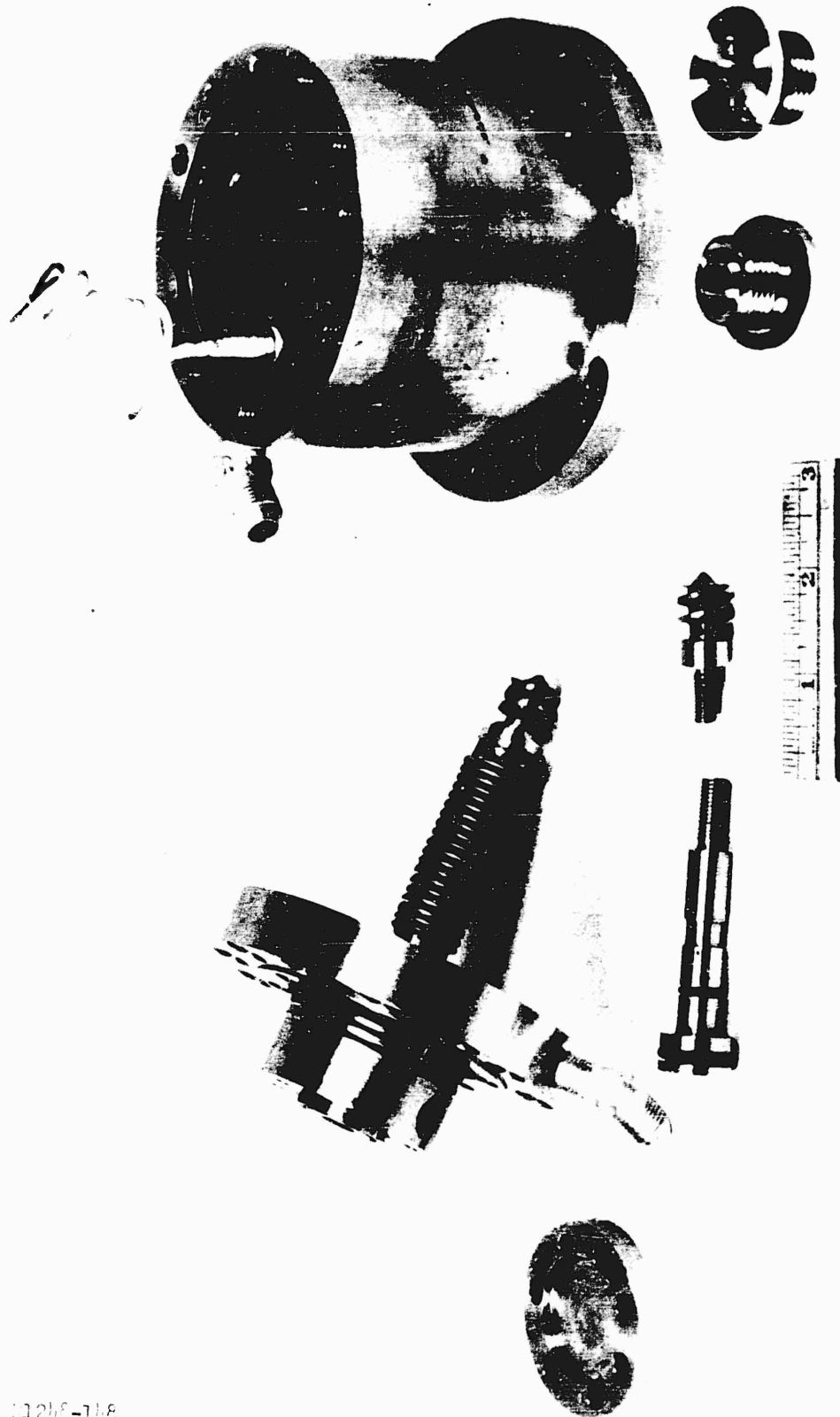
Injector, Type-11 Spiral-Tipped Pintle, Produces Hollow-Cone Spray

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Figure 21



Double-Capacity Injector, Type-15, with Sprayco Nozzle

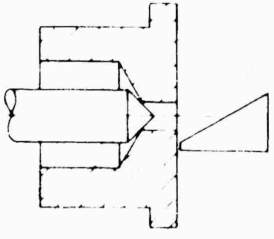
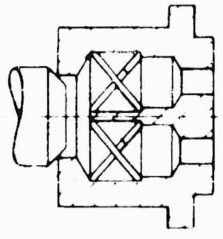
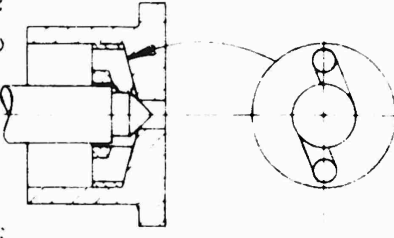
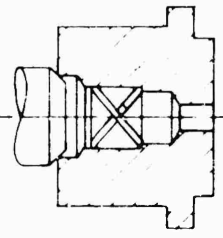
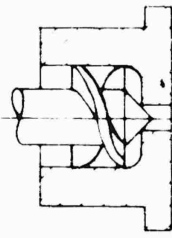
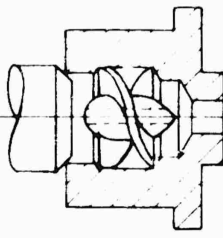
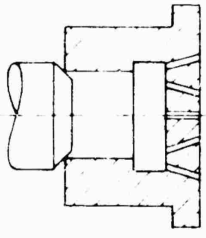
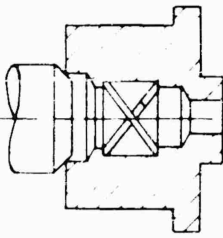
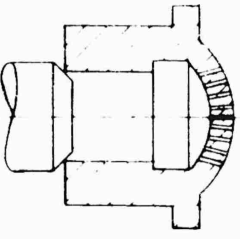
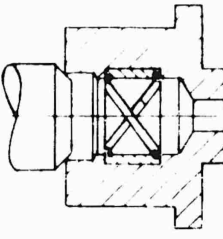


Injector Type-26, Details

11246-148

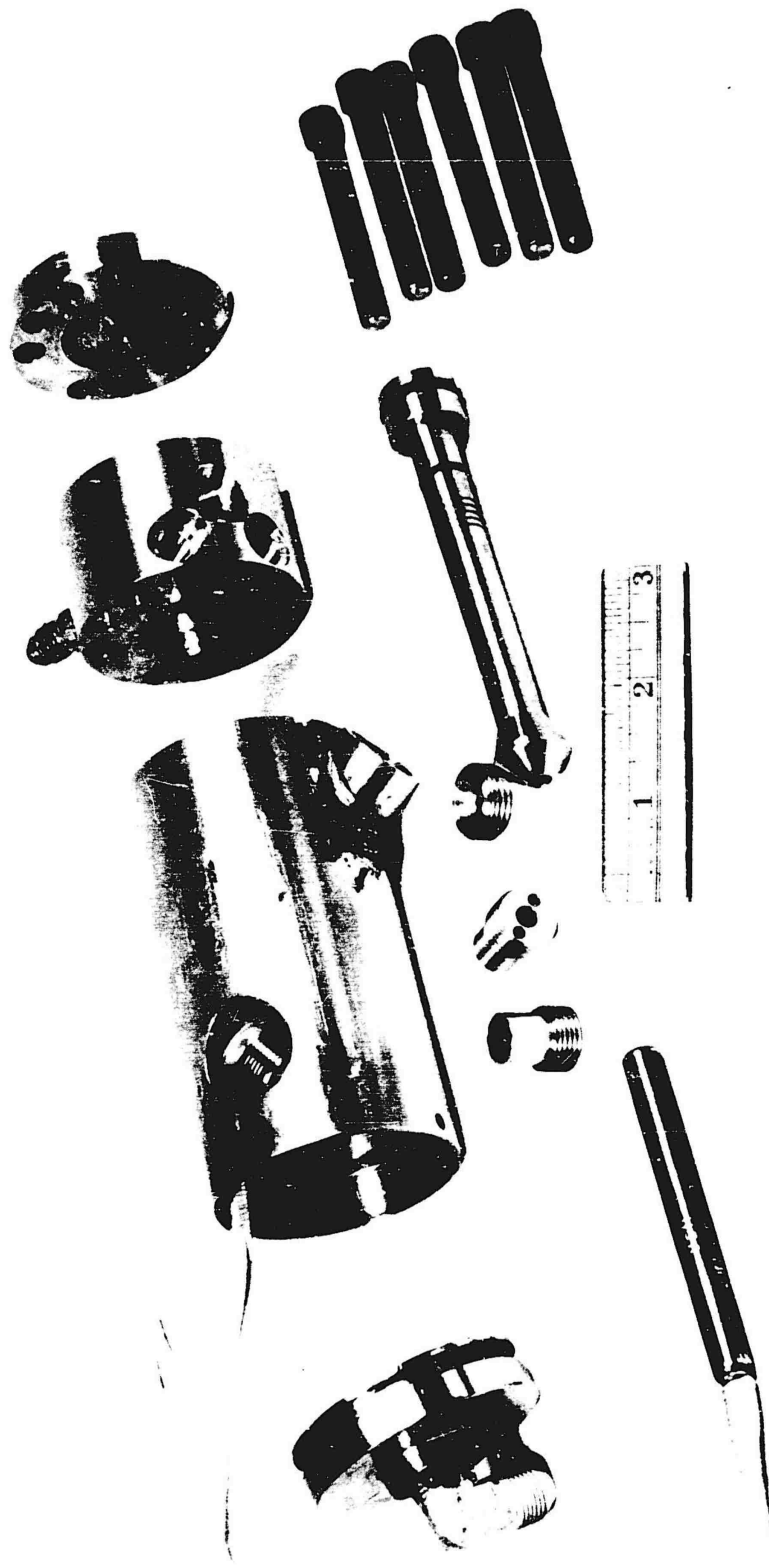
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MECHANISMS FOR PRODUCING THE LITHIUM SPRAY

1.		$C = .73$	REFLECTOR PLATE ORIFICE DIA. - $\begin{cases} .082 \\ .128 \end{cases}$	5.		$C = .59$	TWIN #10 SPRAYCO VANES TWO .157 DIA. HOLES
2.		$C = .59$	TWIN TANGENTIAL PASSAGES ORIFICE DIA. - $\begin{cases} .128 \\ .157 \end{cases}$	4.		$C = .55$	#10 SPRAYCO VANE ORIFICE DIA. - .157
3.		$C = .45$	SPIRAL PINTLE ORIFICE DIA. - .157	9.		$C = .49$	SPIRAL SPRAYCO VANE ORIFICE DIA. - .219
7.		$C = .52$	IMPINGING JETS 57 - .047 DIA. HOLES	8.		$C = .58$	#15 SPRAYCO VANE ORIFICE DIA. - .182
6.		$C = .75$	DIVERGING JETS 65 - .028 DIA. HOLES	10.		$C = .55$	#15 SPRAYCO VANE (REINFORCED) ORIFICE DIA. - .219

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Figure 24



Injector, Type-27 Details

R6L9-65



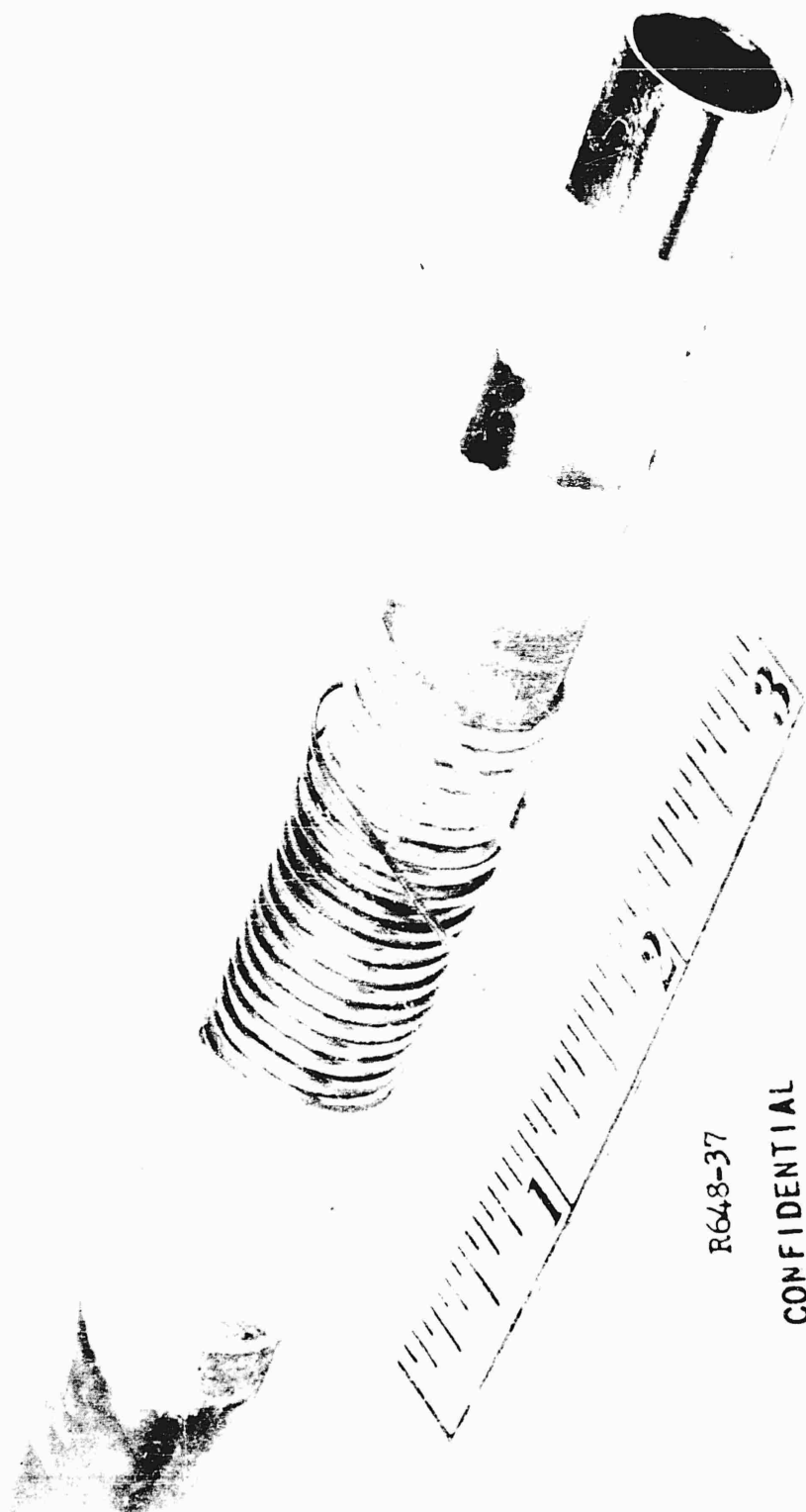
3
2
1

Fuel-Valving Pintle Tips, the Old and the Improved



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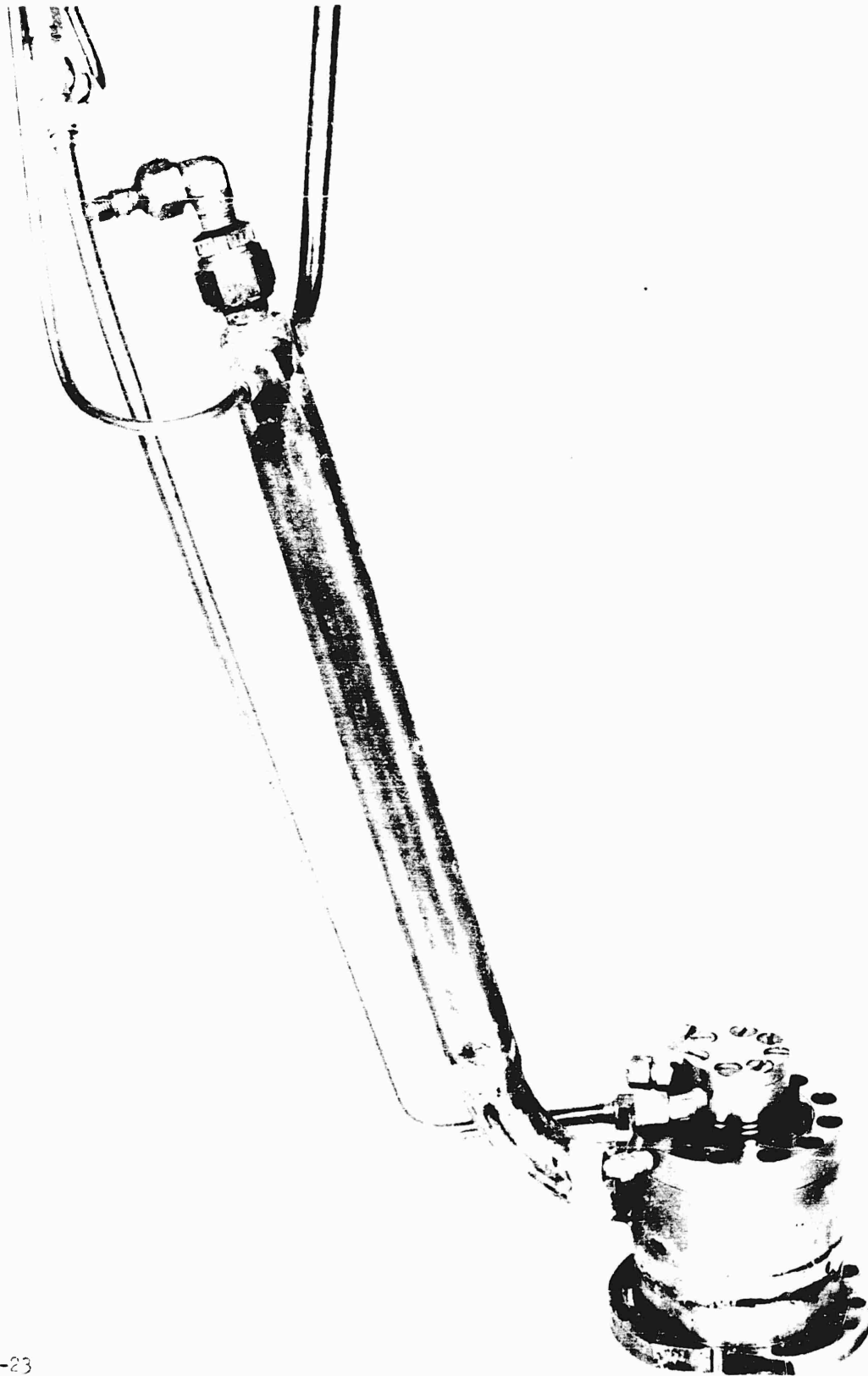
Heated Molten Lithium Fuel Line, Showing Methods of Construction

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Figure 28

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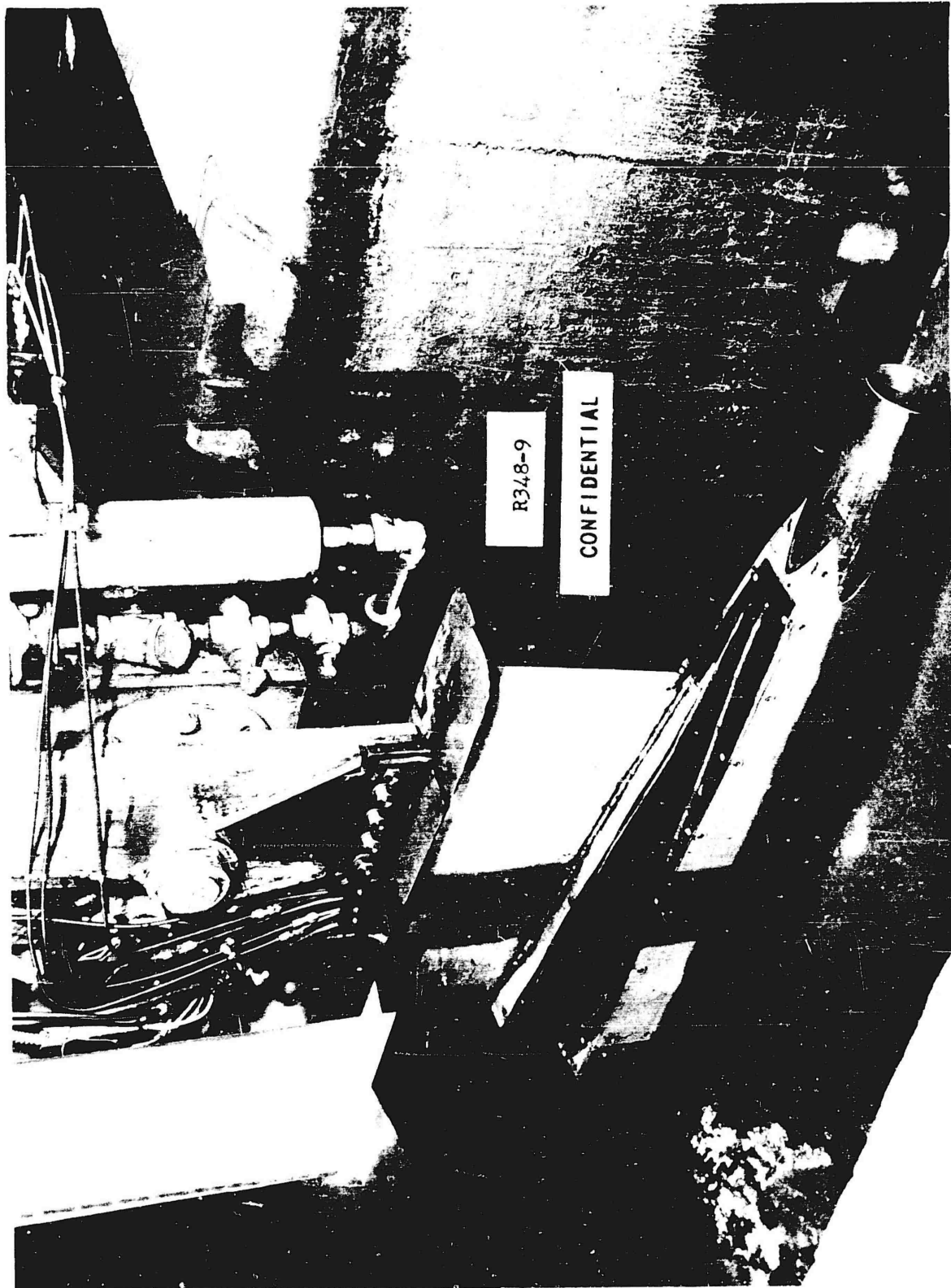


1149-23

Split-Tube Water Barrier

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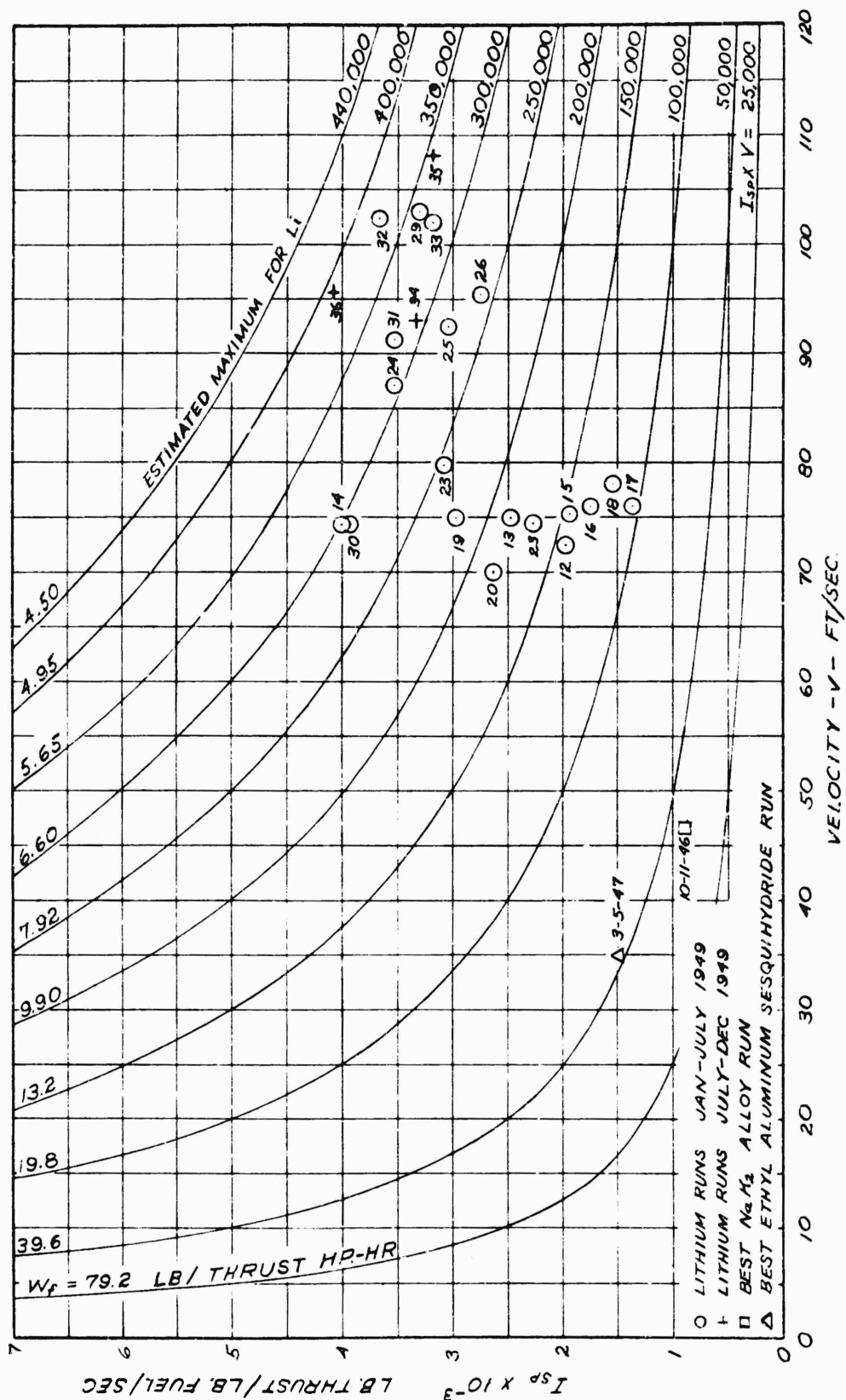
Figure 29

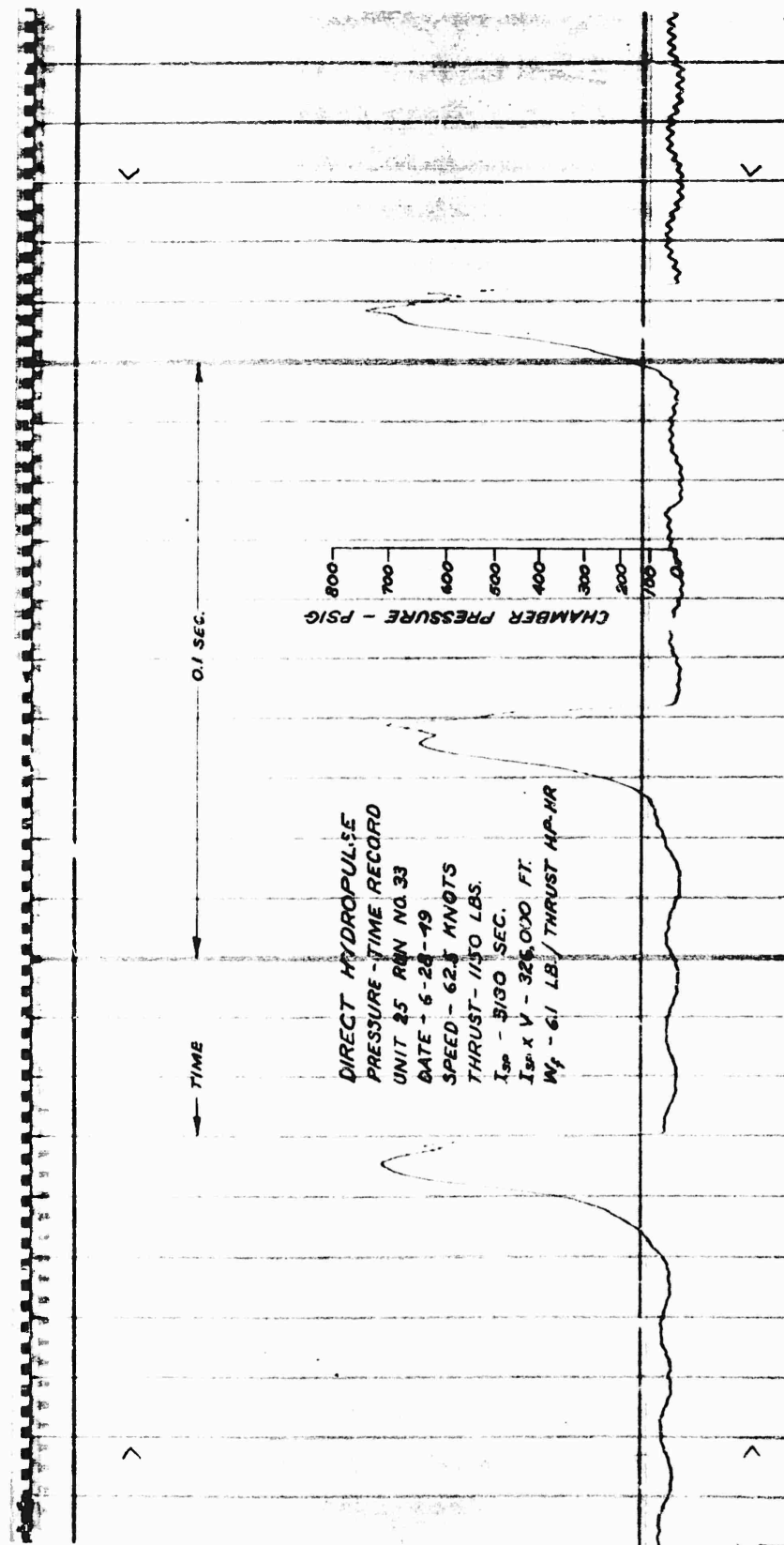


Hydropulse Unit 22-B, Showing Method of Mounting on Boom

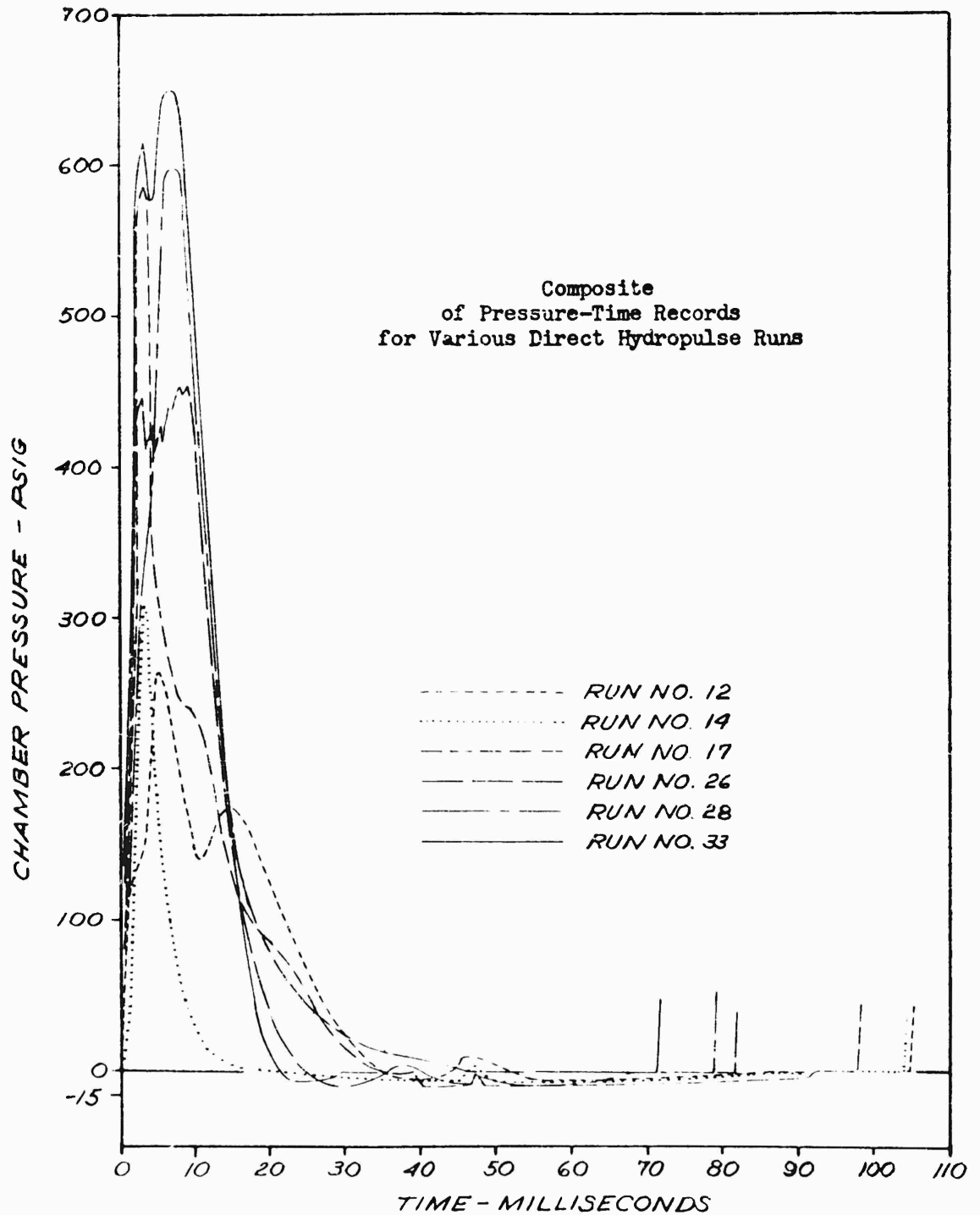
CURVE NO. 4022 H. HIGGINS 7-8-49 (REVISED)

EXPERIMENTAL POINTS OF DIRECT HYDROPLUSE PERFORMANCE





CURVE NO. 4028 H. HIGGINS - 7-19-49



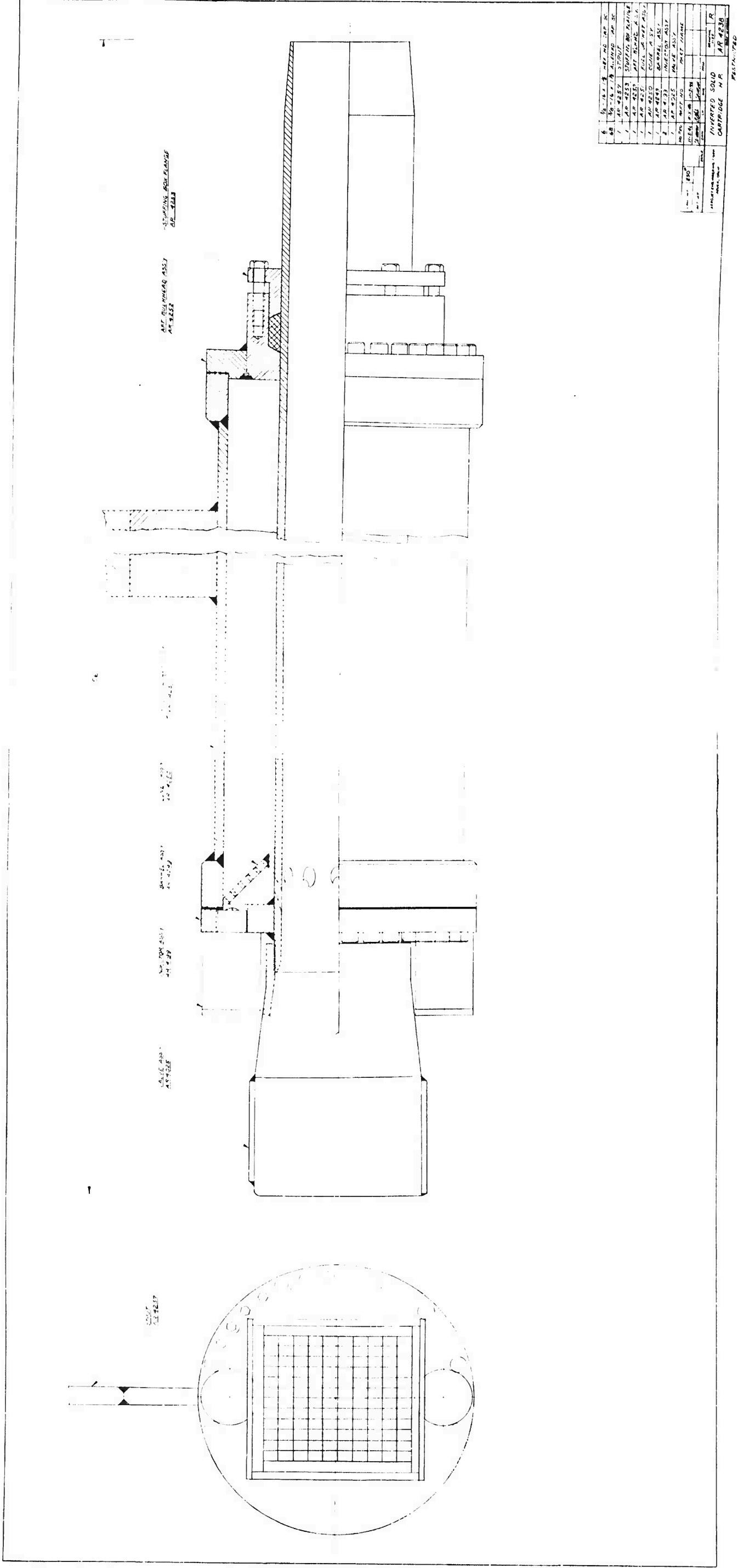
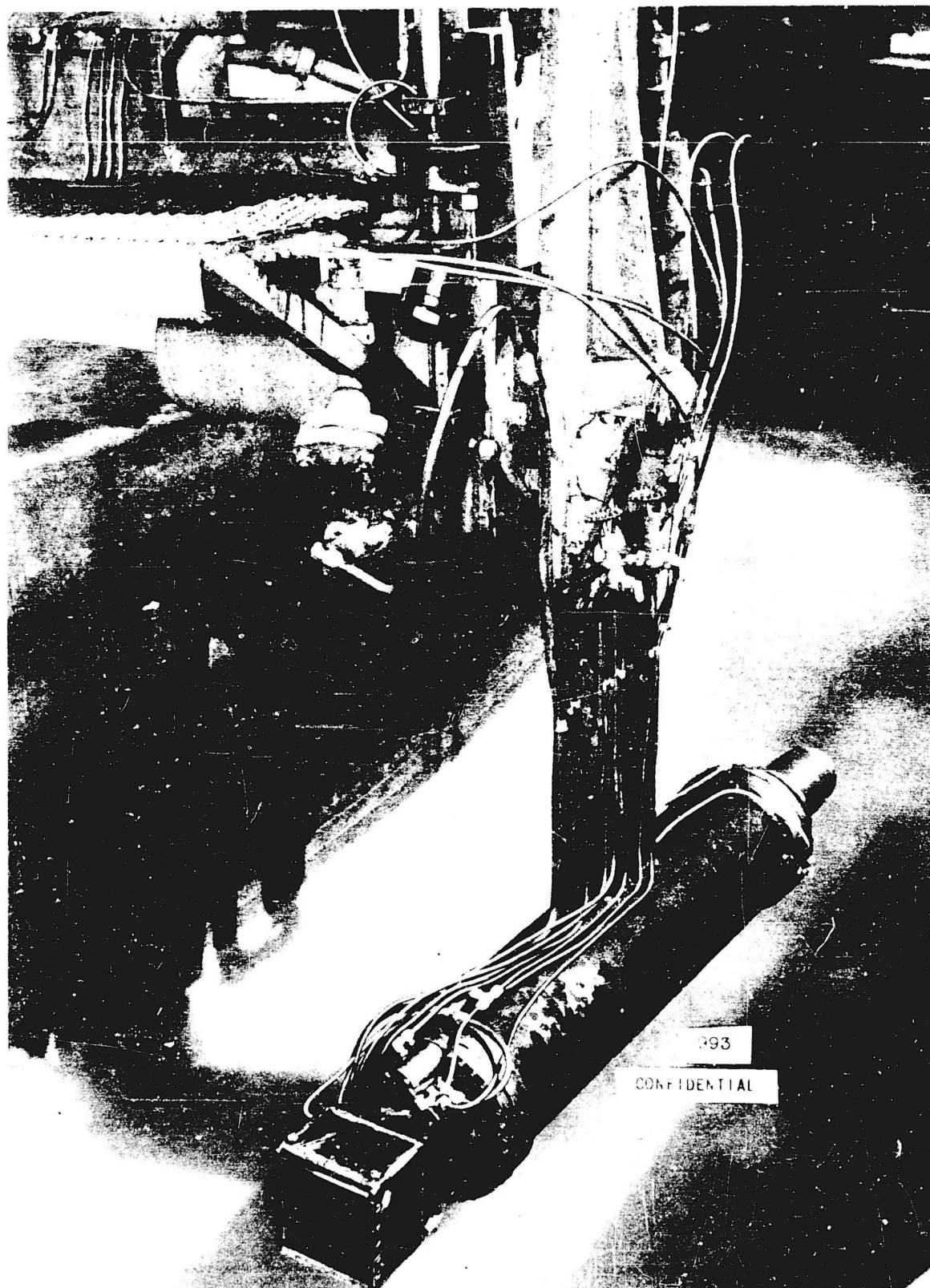


Figure 34
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Unit 15, Inverted Solid-Sodium Cartridge Hydropulse

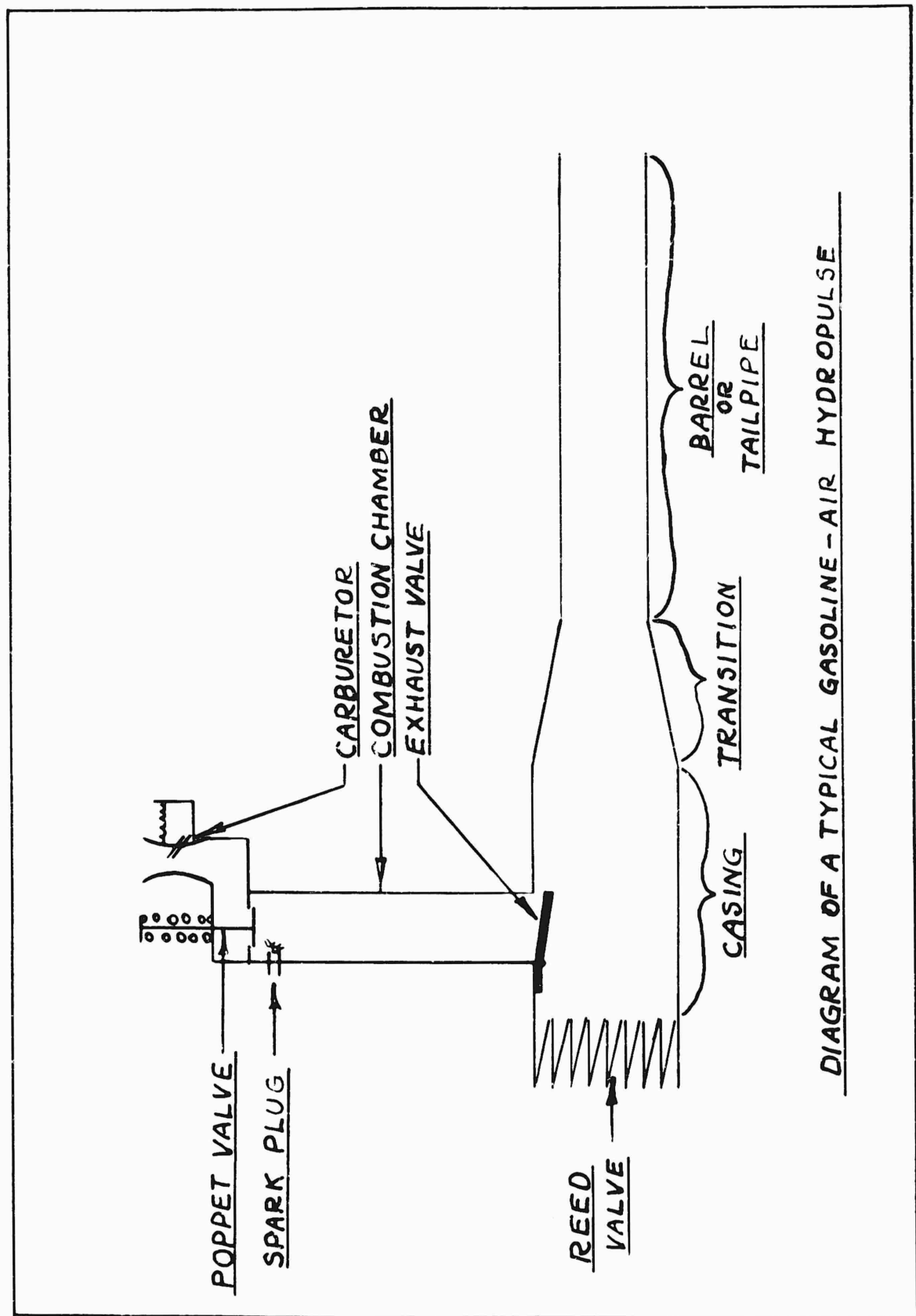


DIAGRAM OF A TYPICAL GASOLINE-AIR HYDROPULSE

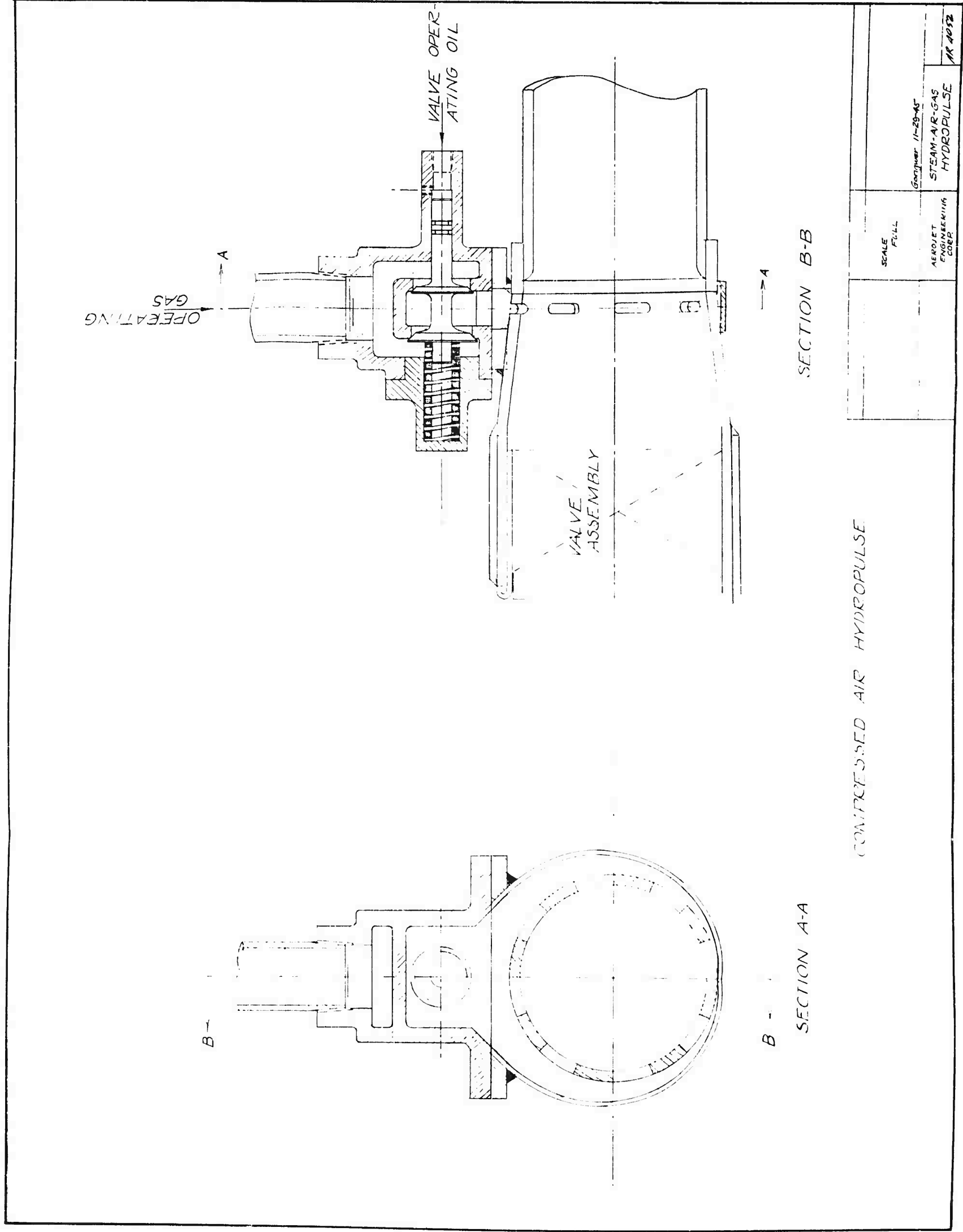
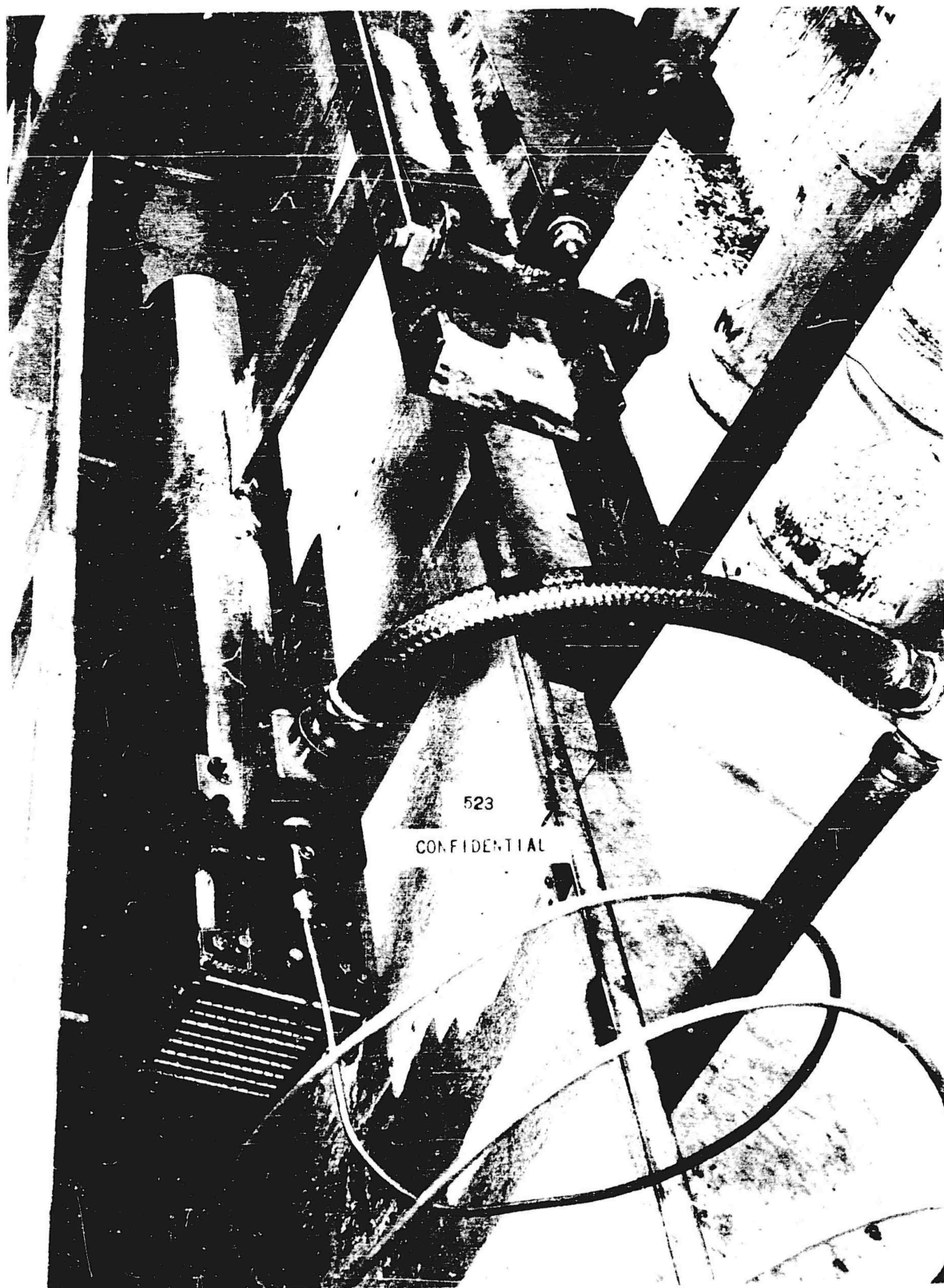


Figure 37

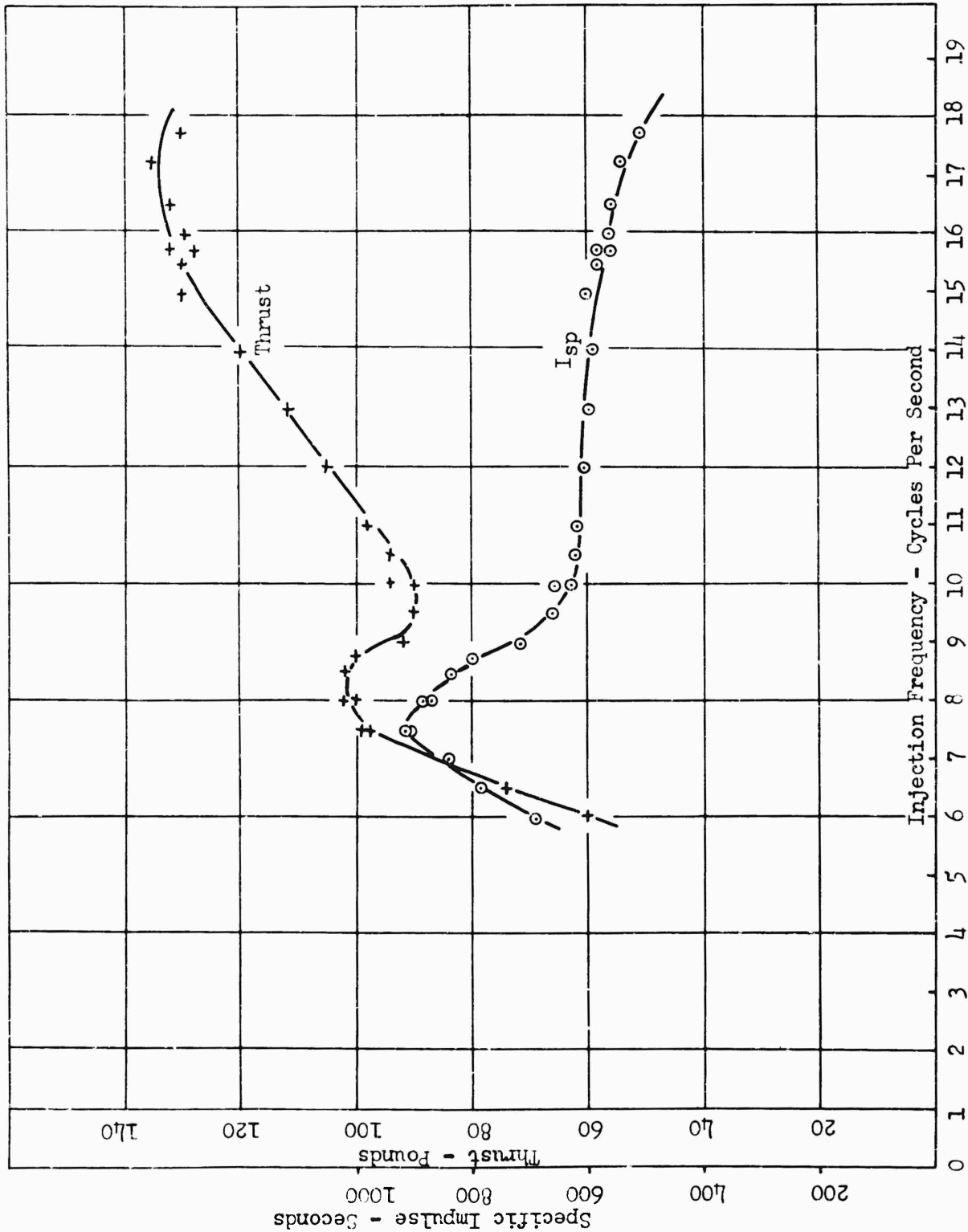
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Compressed-Air Hydro-pulse Mounted in the Stationary Test Tank

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Performance vs Injection Frequency, Single Barrel, 1" Diameter 3'-0" Long
Inlet Air Pressure 250 Psig, Compressed Air Hydropulse, Zero Speed

Figure 39

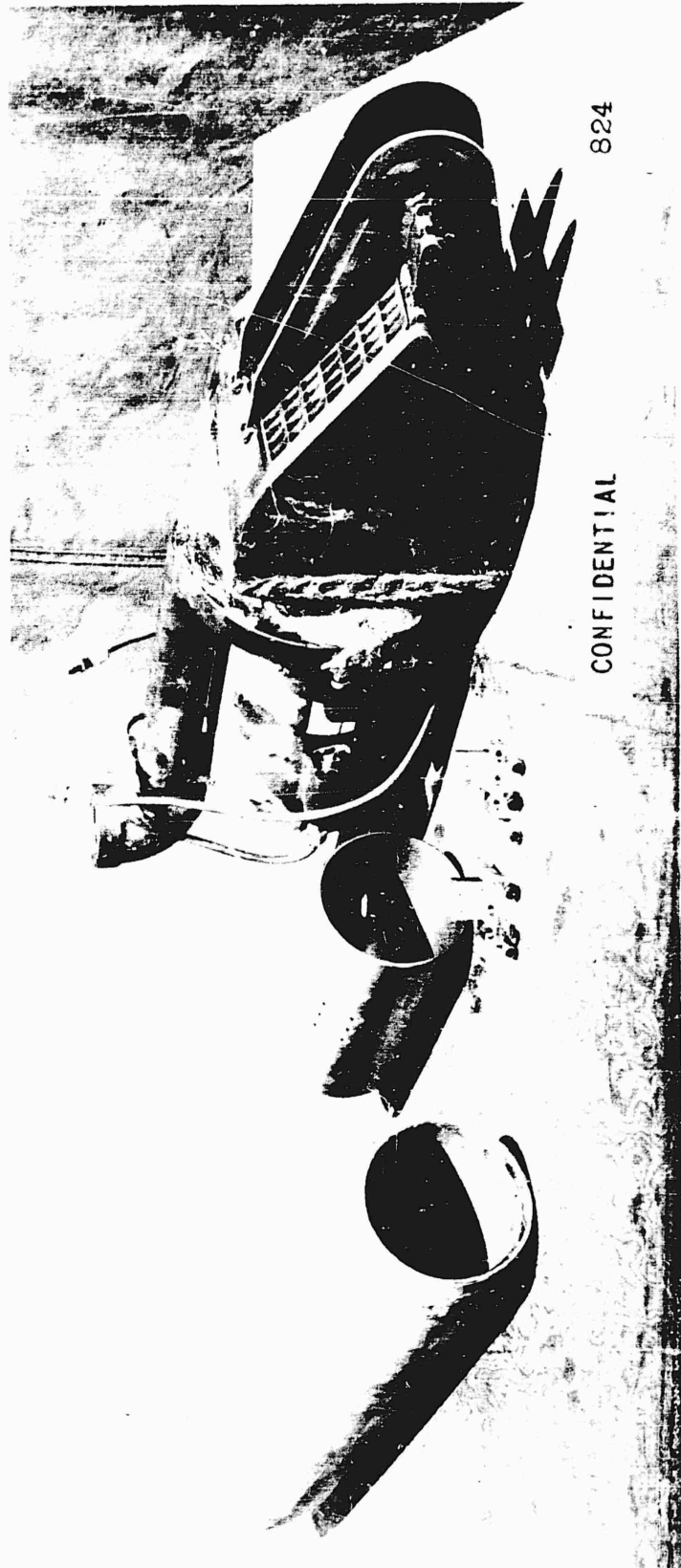
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Assembly of Nitromethane Gas Hydropulse

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824

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Sleeve-Valve Nitromethane Hydropulse Disassembled

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Figure 41

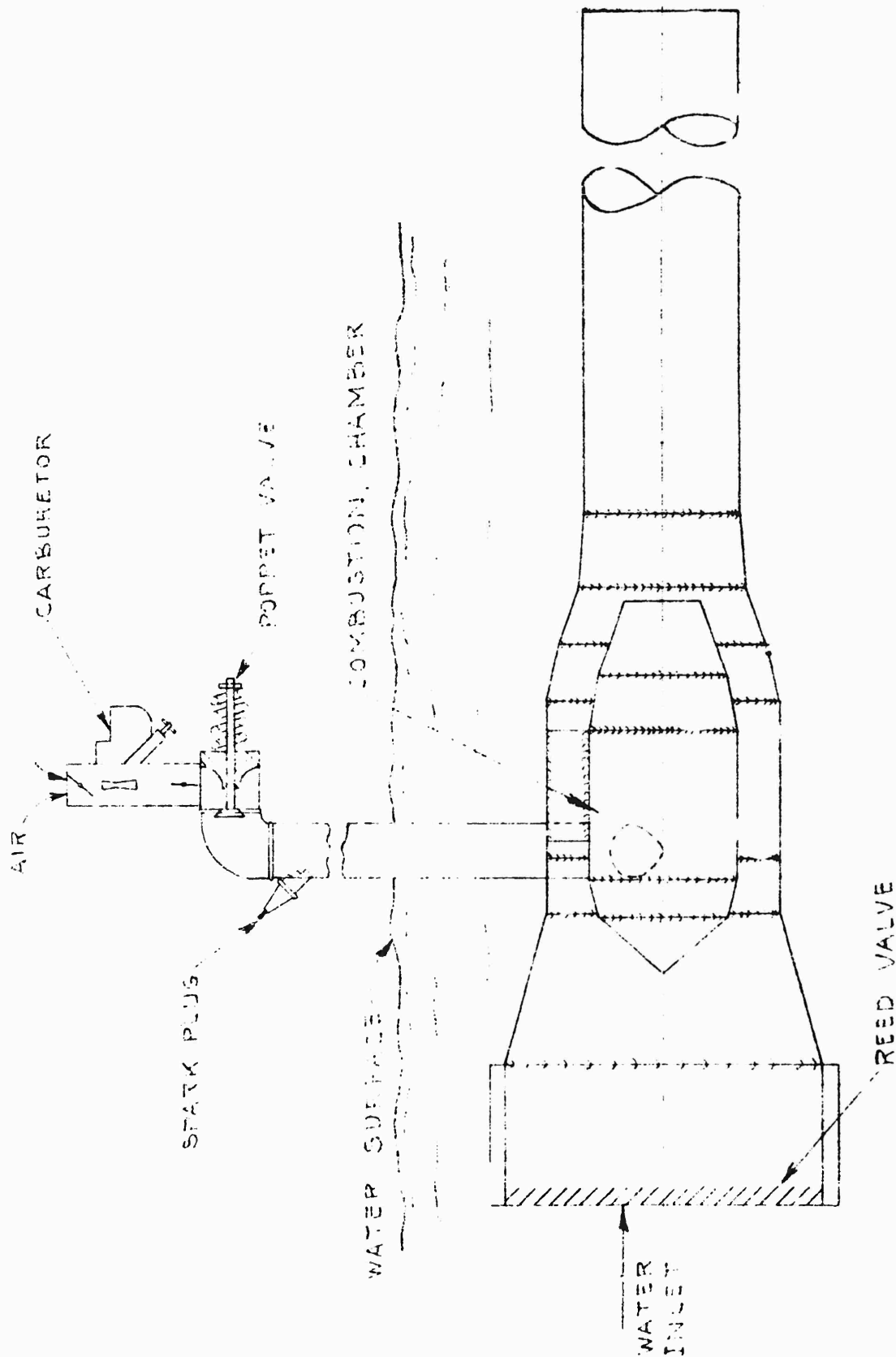


DIAGRAM OF GASOLINE - AIR
HYDEOPULSE

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MISCELLANEOUS G.A.H. MODELS

Report No. 1106


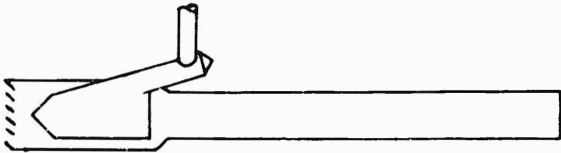
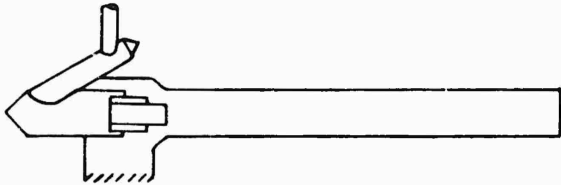
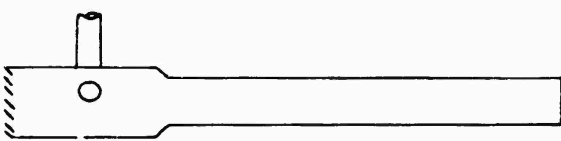
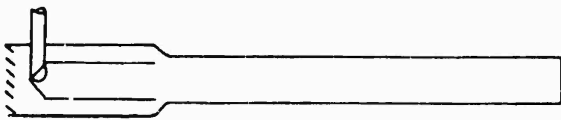
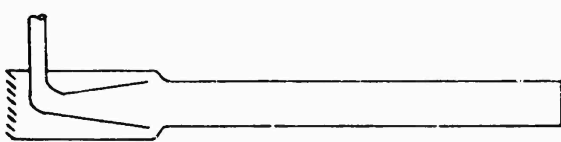
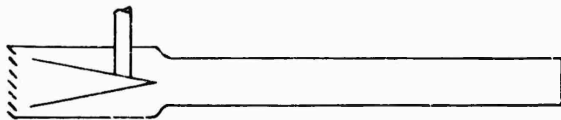
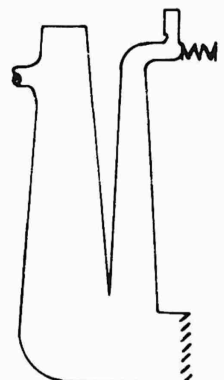
<u>SKETCH</u>	<u>MODEL NO.</u>
	G.A.H.-24
	G.A.H.-31
	G.A.H.-32
	G.A.H.-35
	G.A.H.-36
	G.A.H.-37
	G.A.H.-38
	G.A.H.-39

Figure 43

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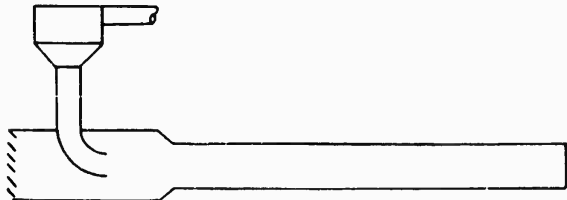
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Report No. 1106

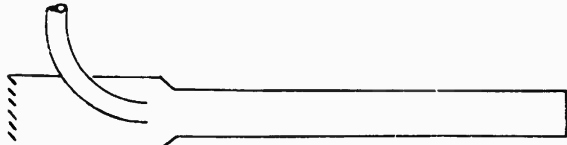
MISCELLANEOUS G.A.H. MODELS

SKETCH

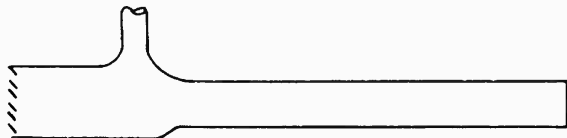
MODEL NO.



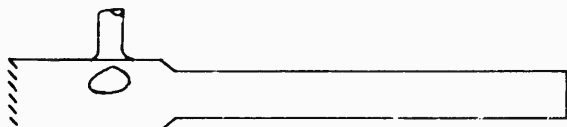
G.A.H.-40



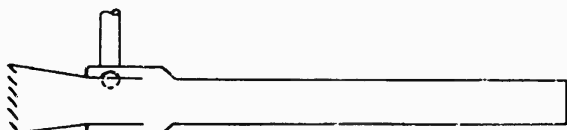
G.A.H.-41



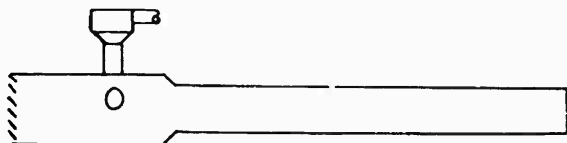
G.A.H.-42



G.A.H.-43



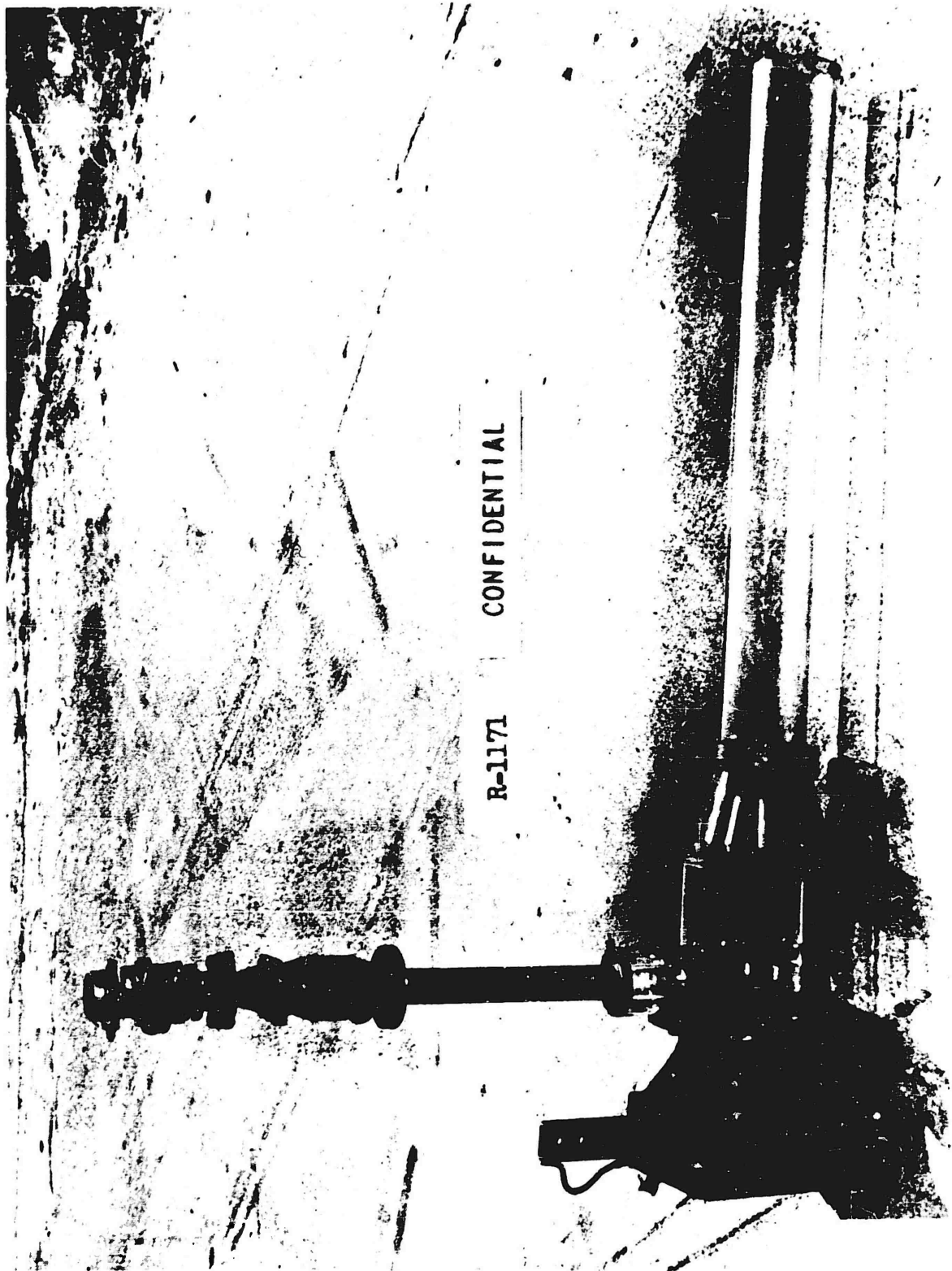
G.A.H.-44



G.A.H.-46A

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Figure 44



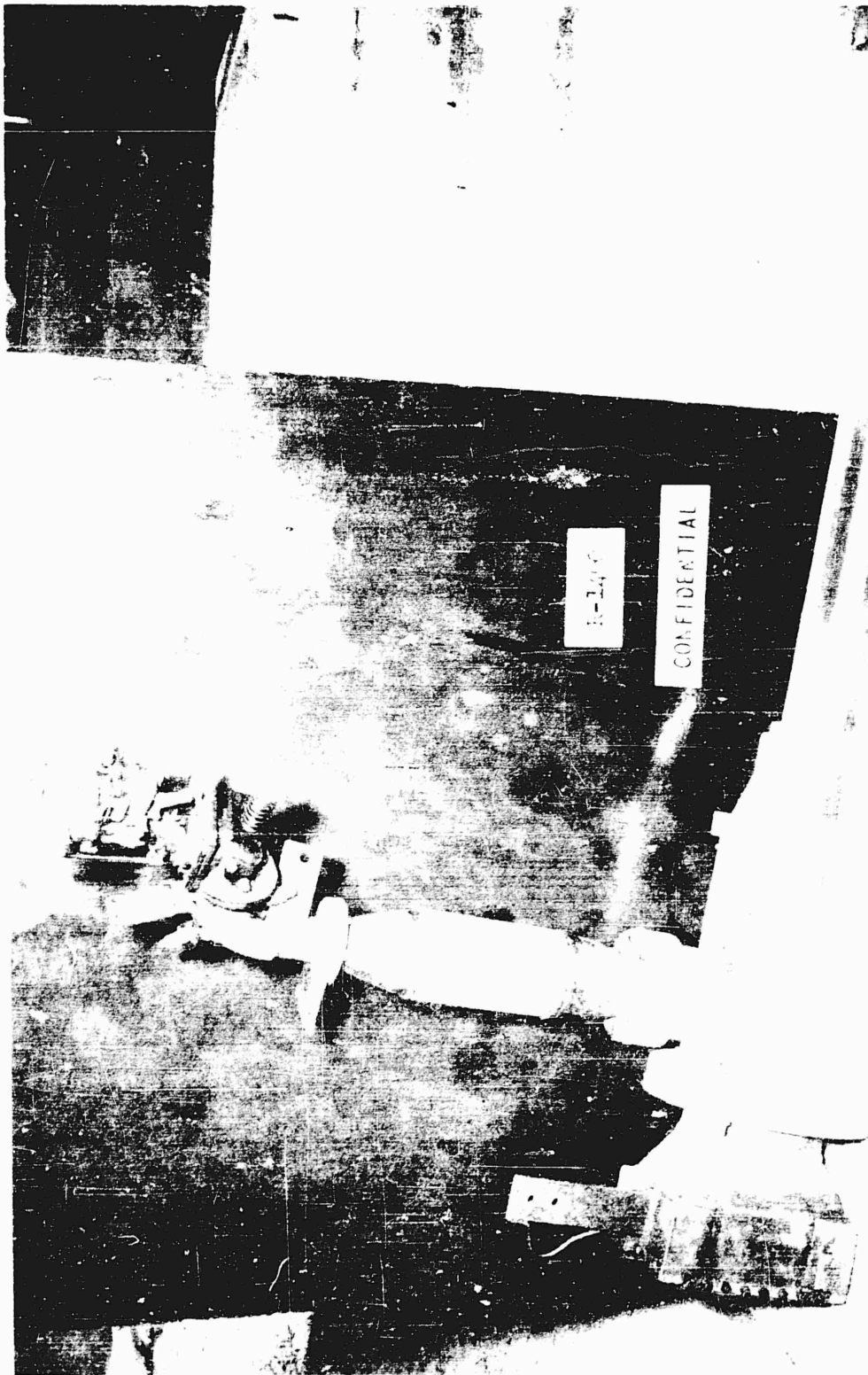
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R-1171

Lucite Model of Gasoline-Air Hydropulse

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Report No. 1106



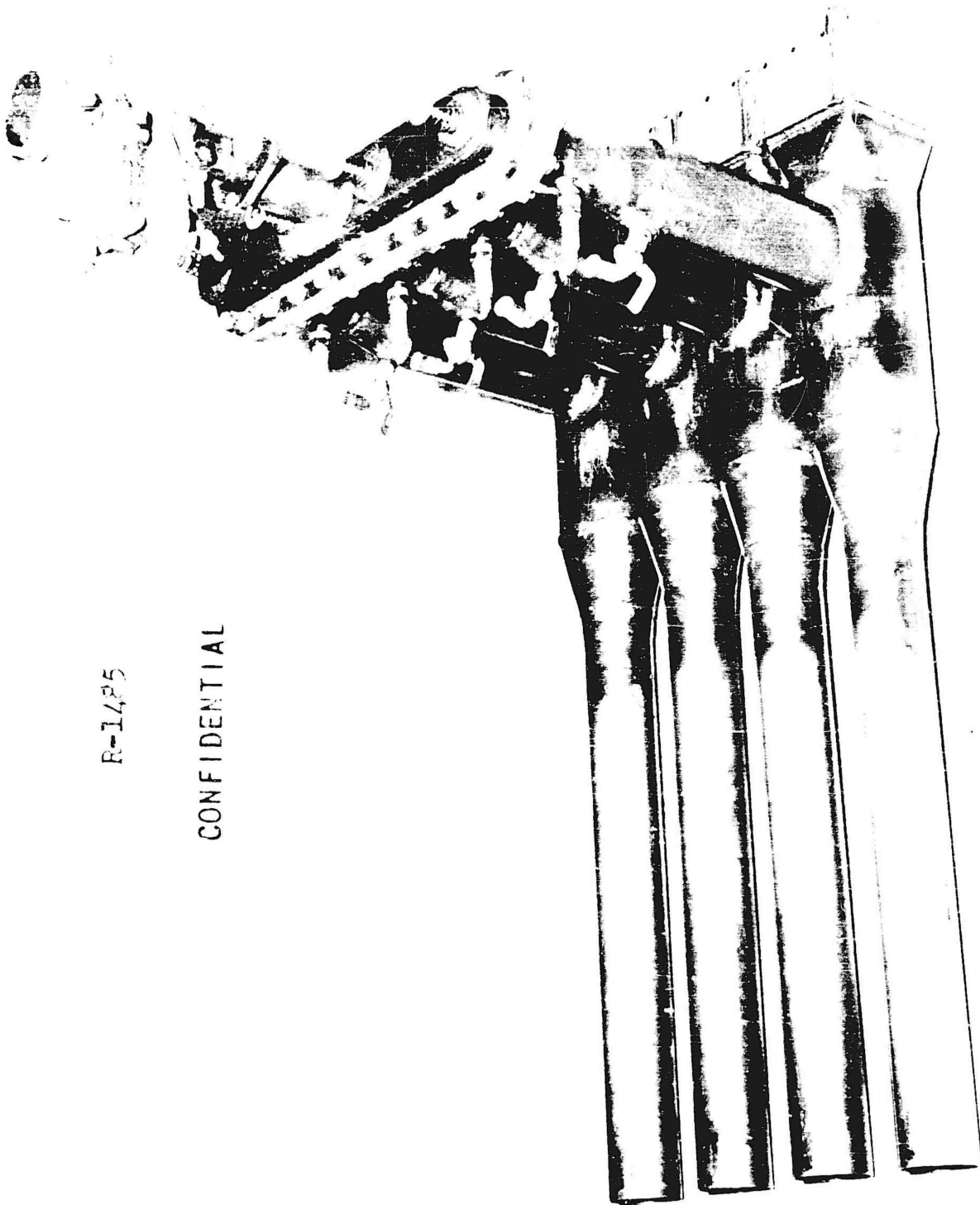
Incite Model

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Figure 116

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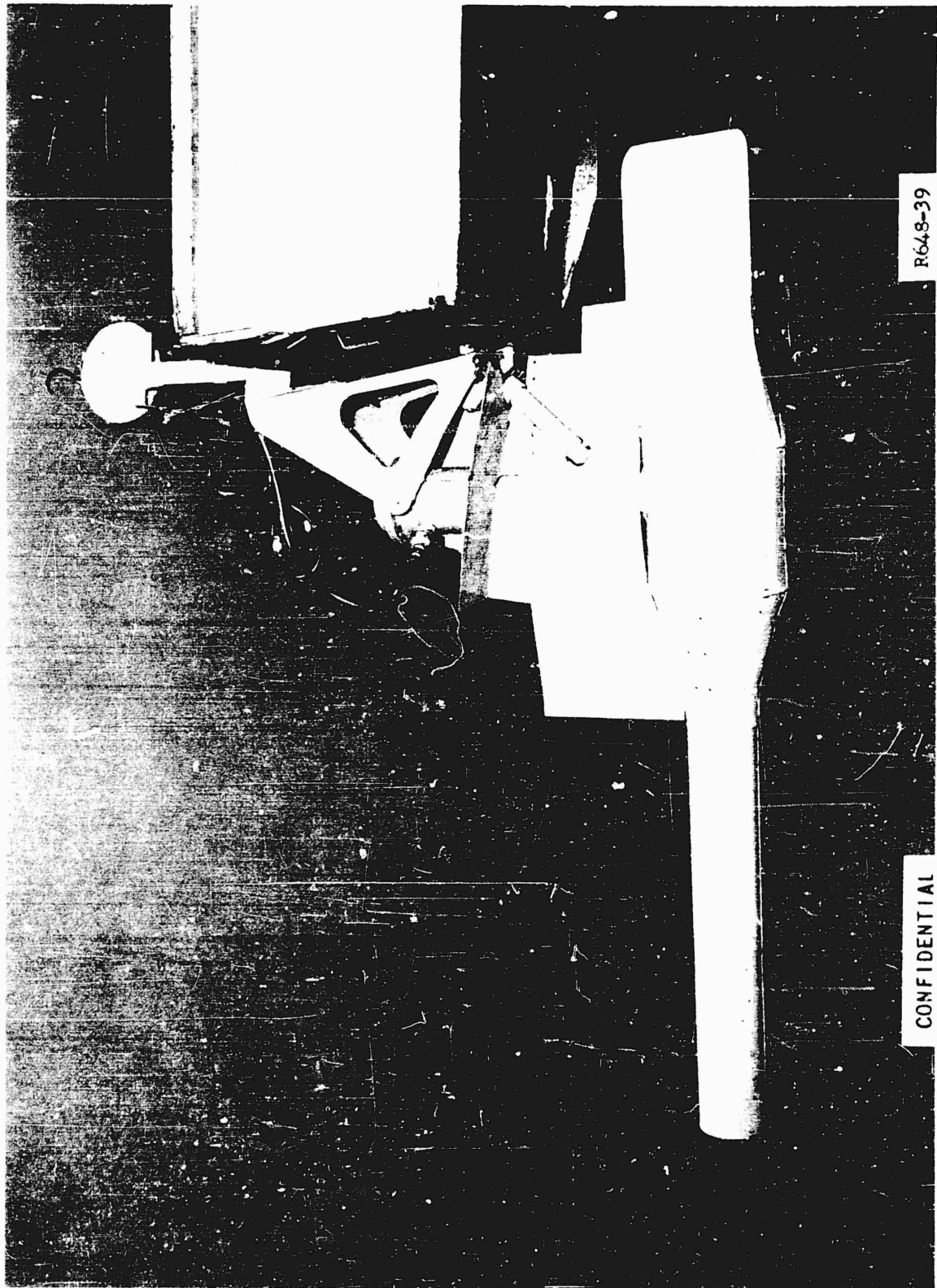
R-1425

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A Four-Ducted Motor

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Figure 47



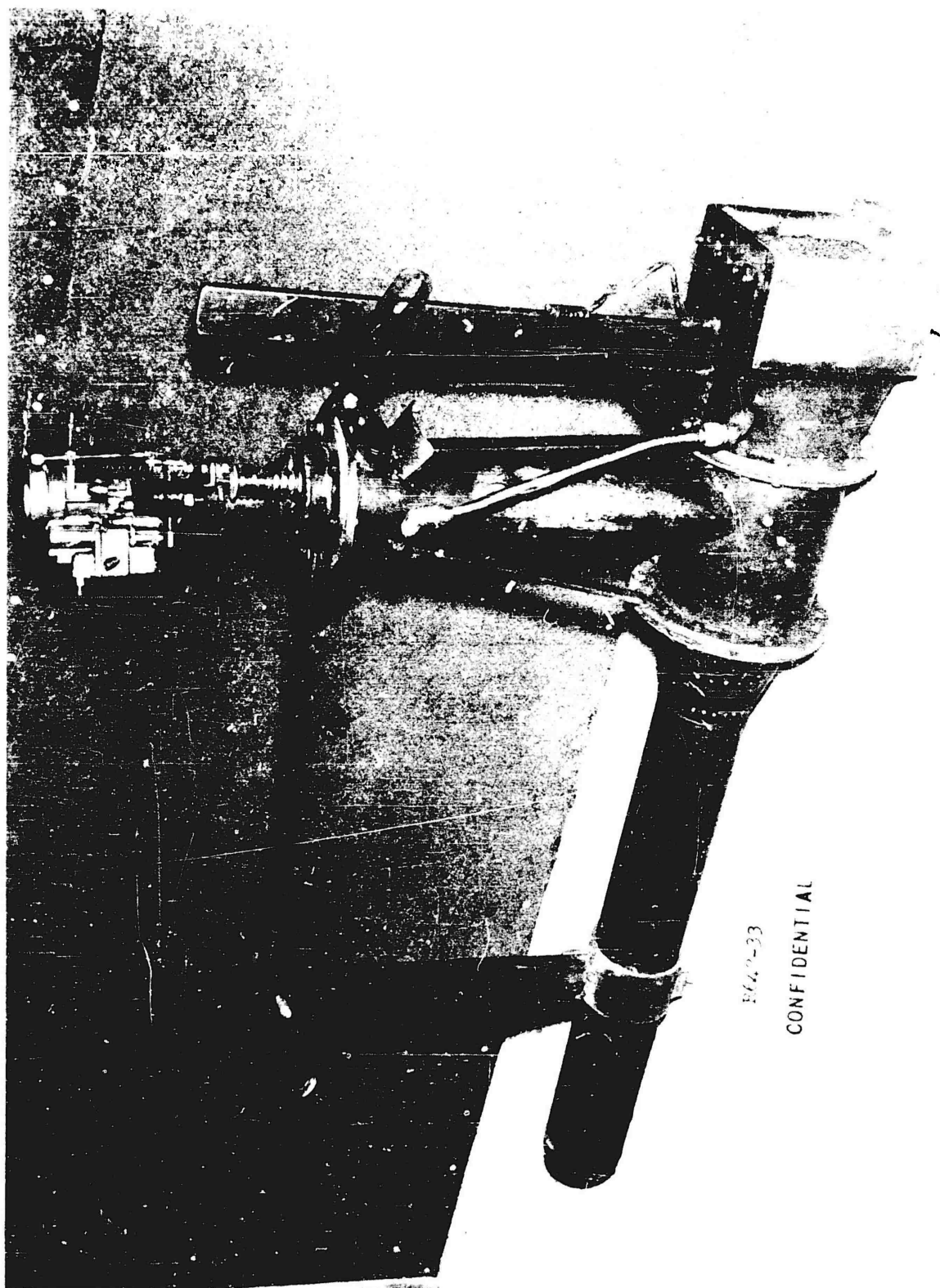
R648-39

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A Streamlined Unit Mounted on the Skiff for Dynamic Testing

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Report No. 1106



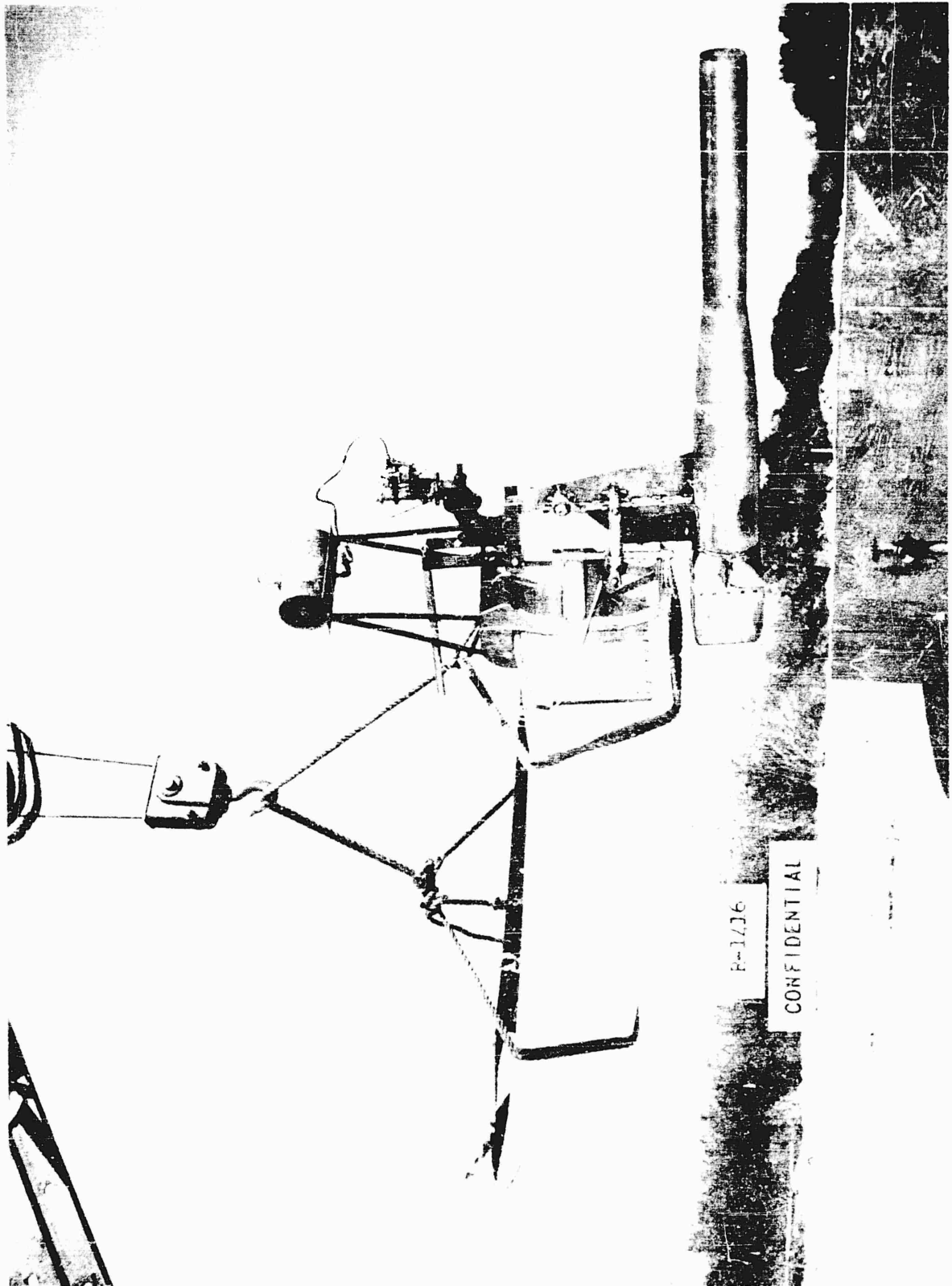
DAH-92 Assembly

8447-33

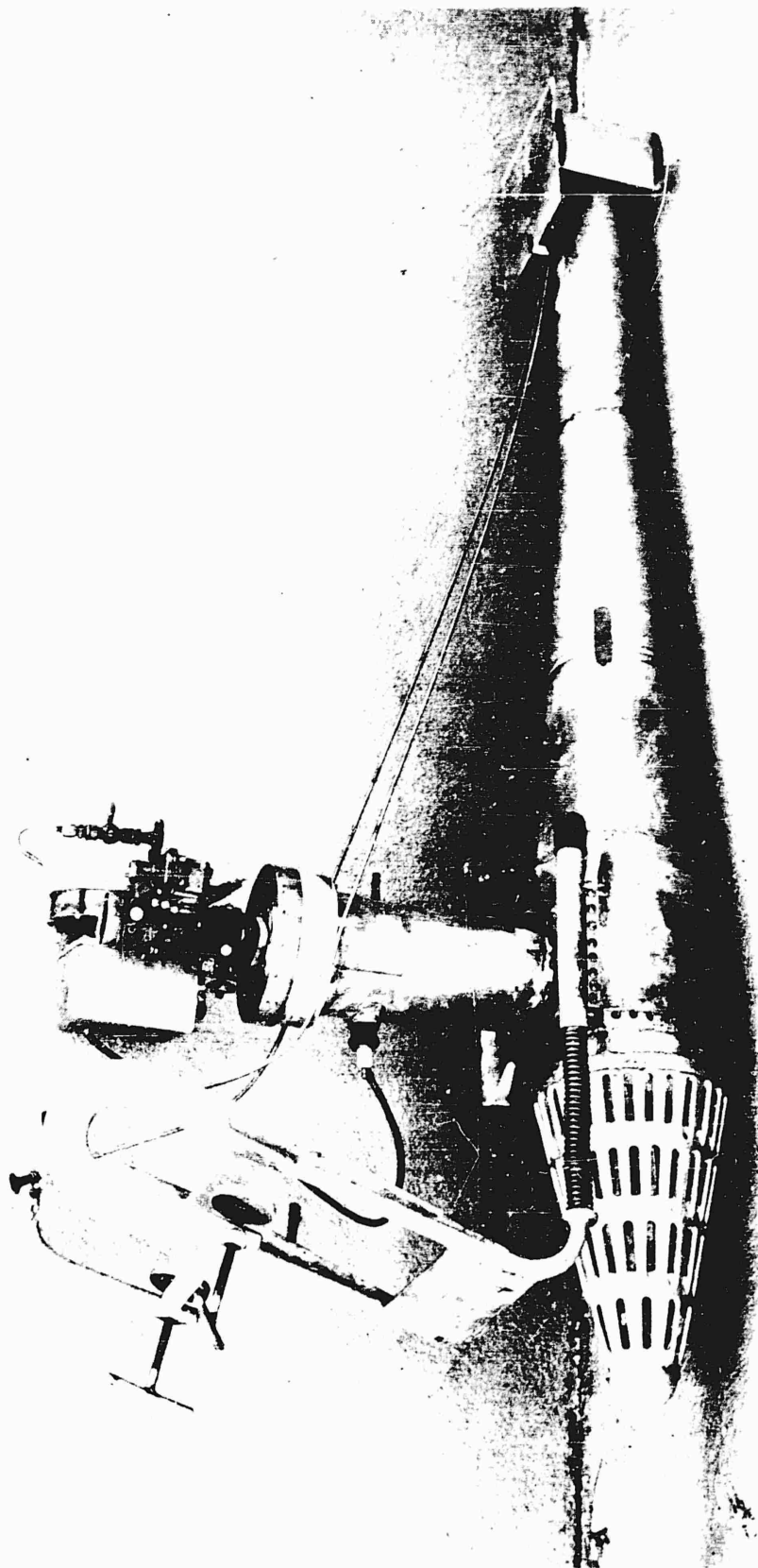
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Figure 49



Correlation Model Hoist mounted on the 17-ft boat

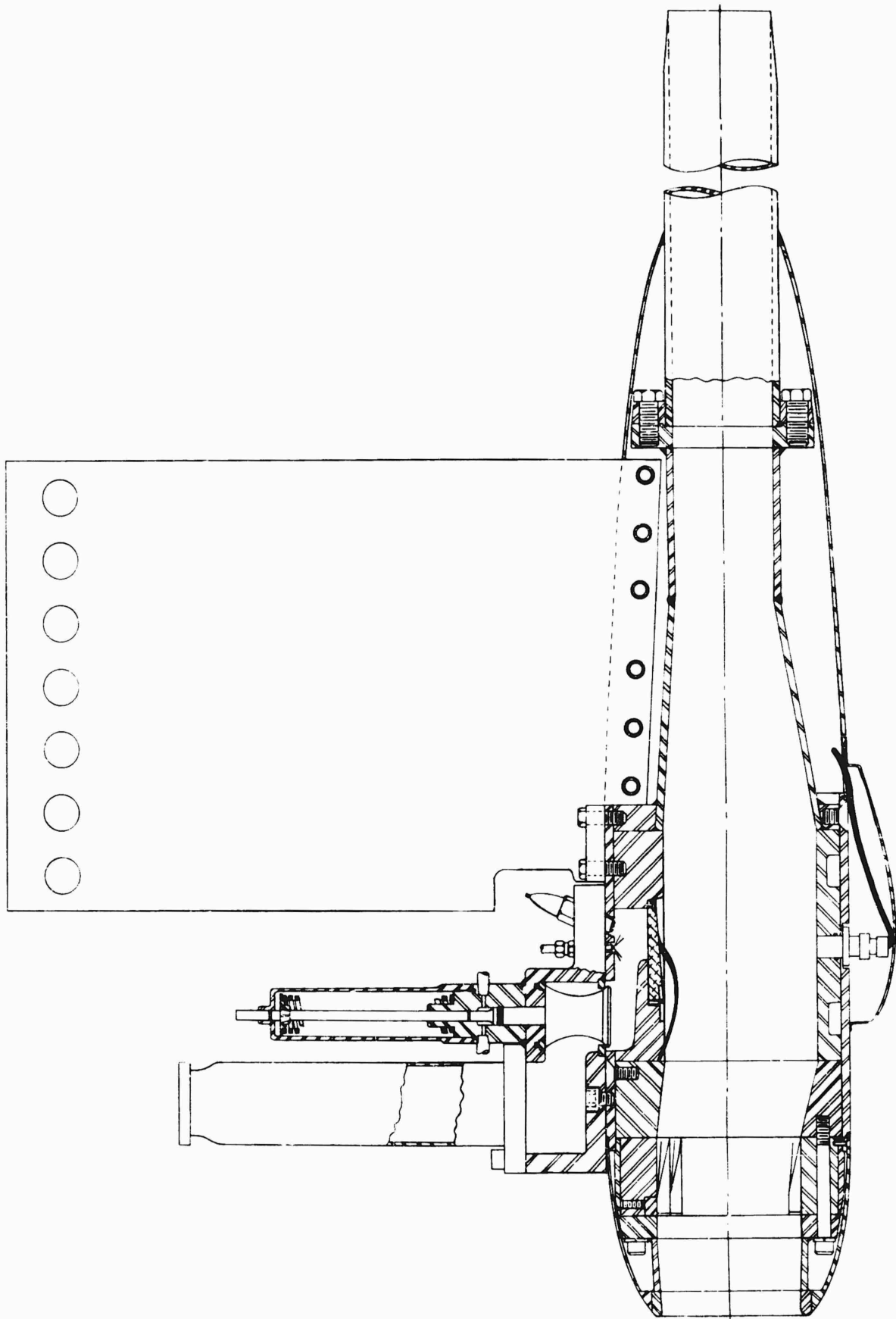


GAI-106 Complete with Harbeto

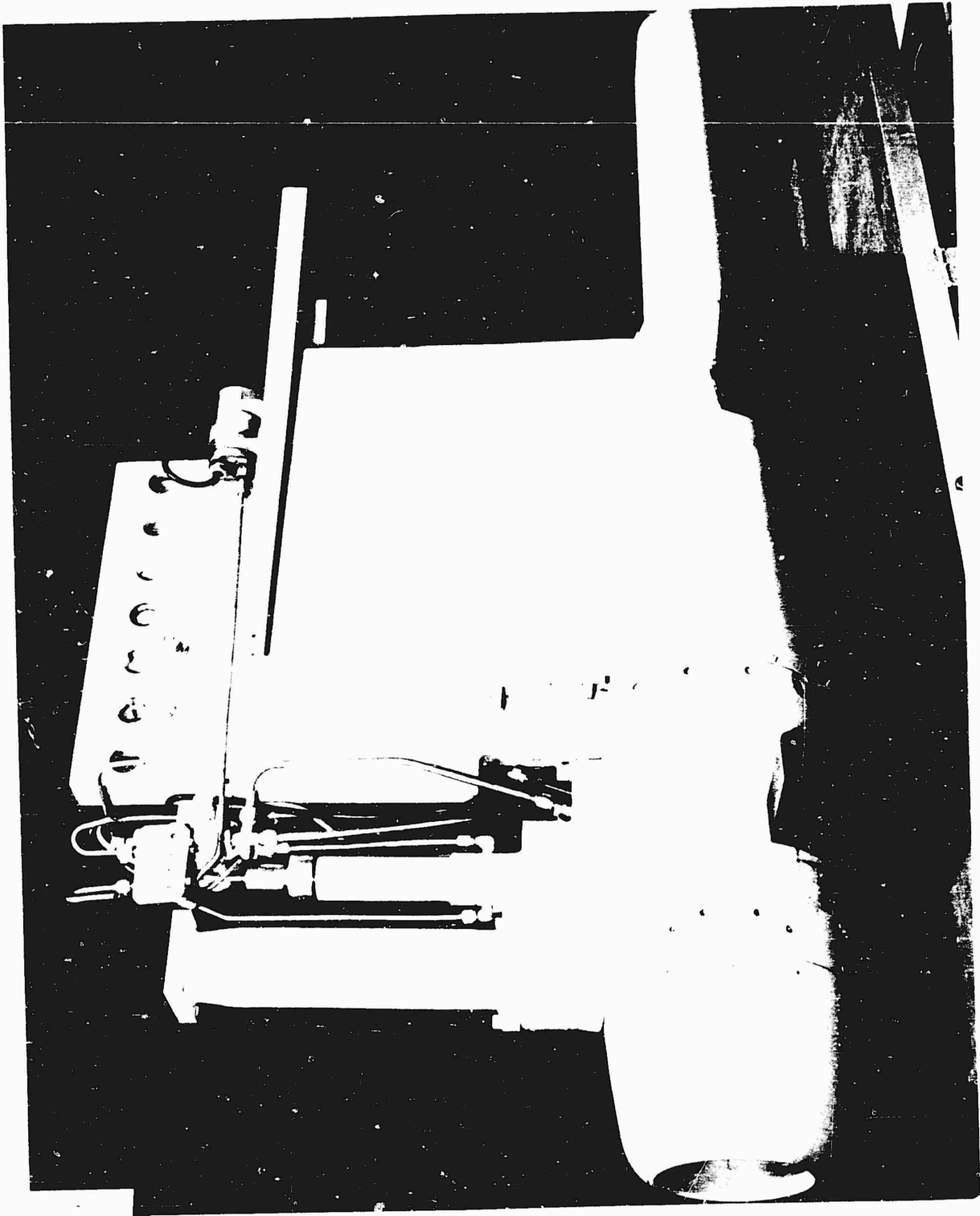


Standard-Irid Reed Valve

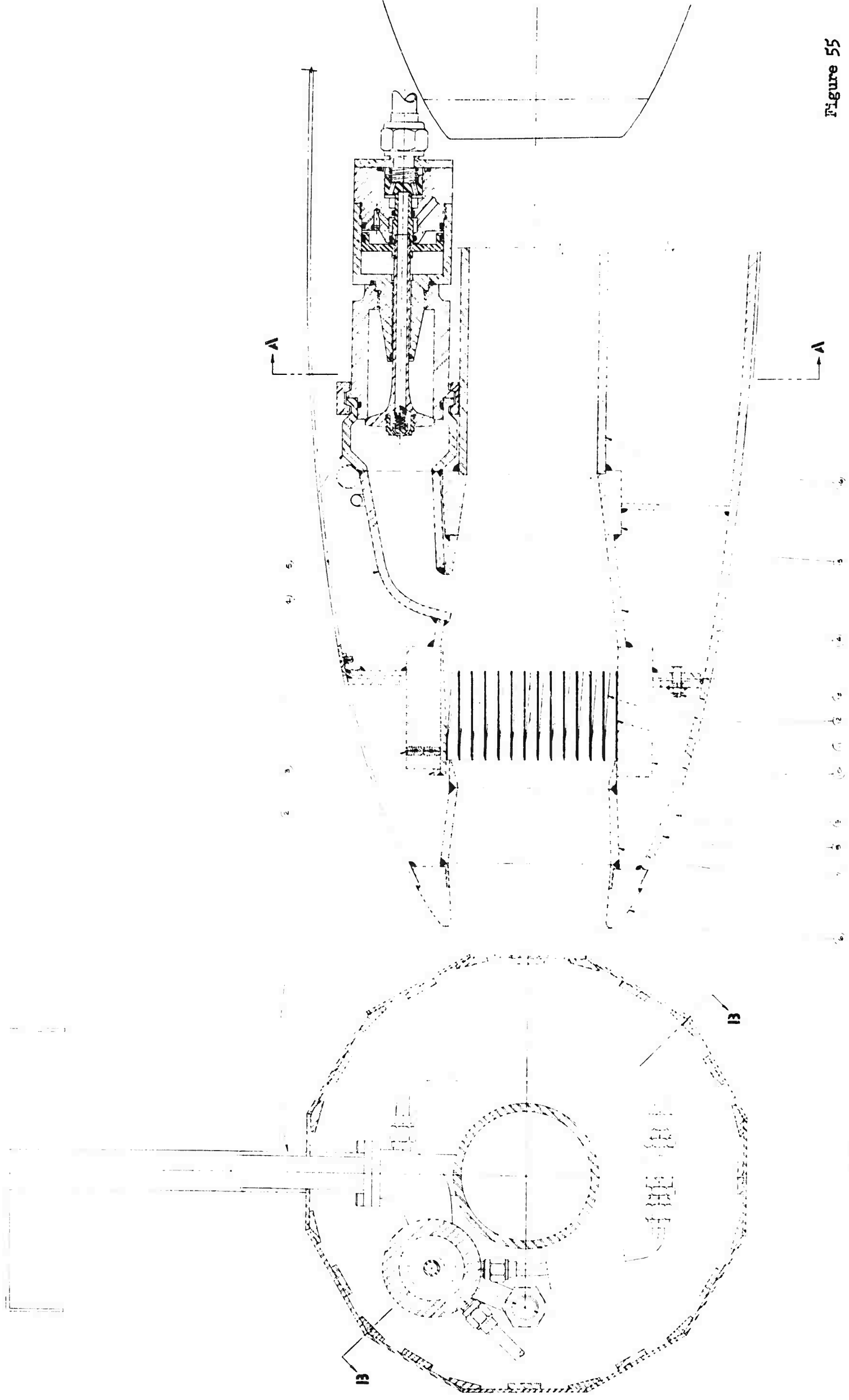
8719-19



GASOLINE - COMPRESSED AIR HYDROPLANE



View of a Gasoline-Air Hydropulse



SECTION A-A

Mark II Gas-Air Hydropulse

SECTION B-B

Figure 55

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Report No. 1106



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R-1403

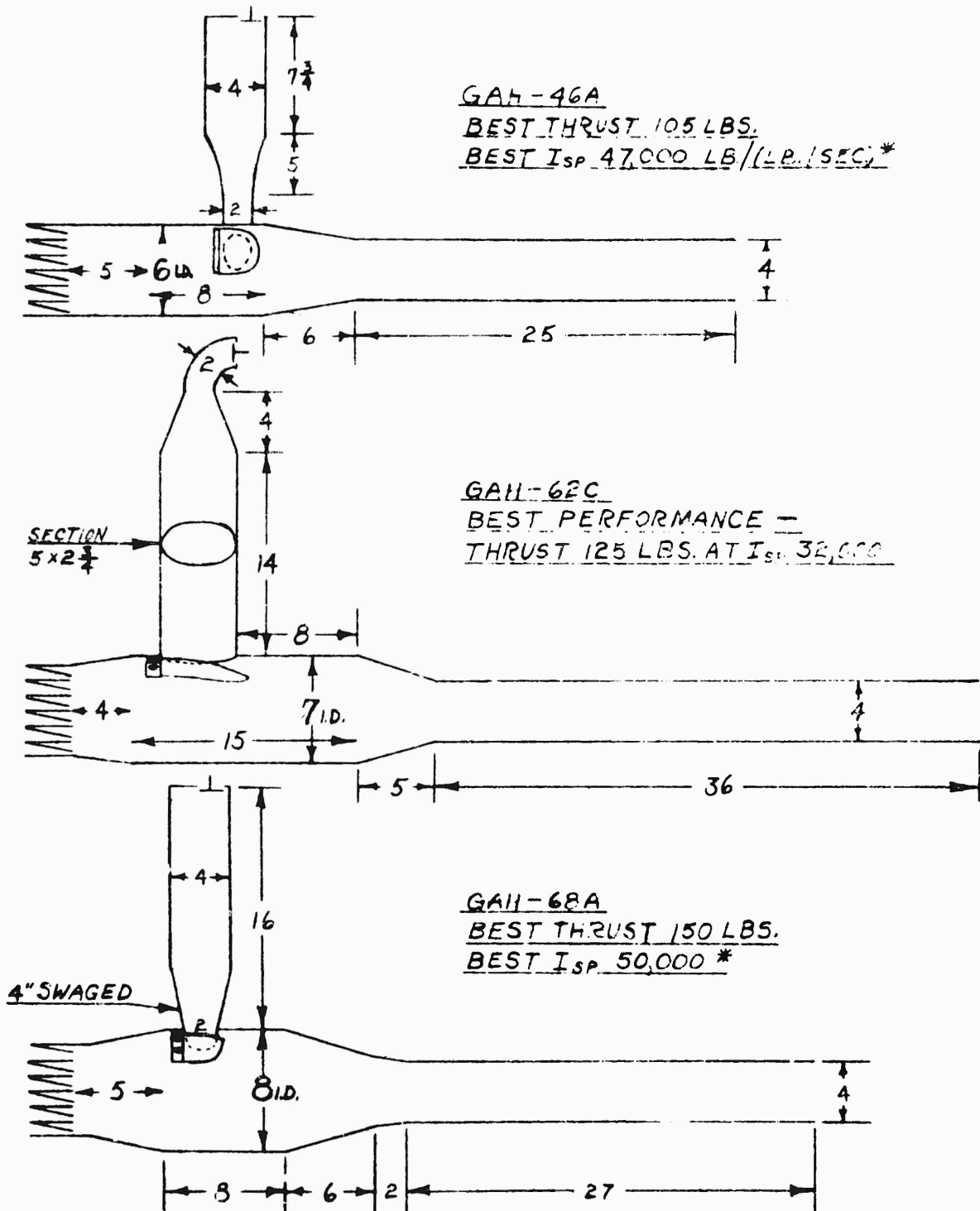
View of GAF-262L Showing the Rubber Flap Valve

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Figure 56

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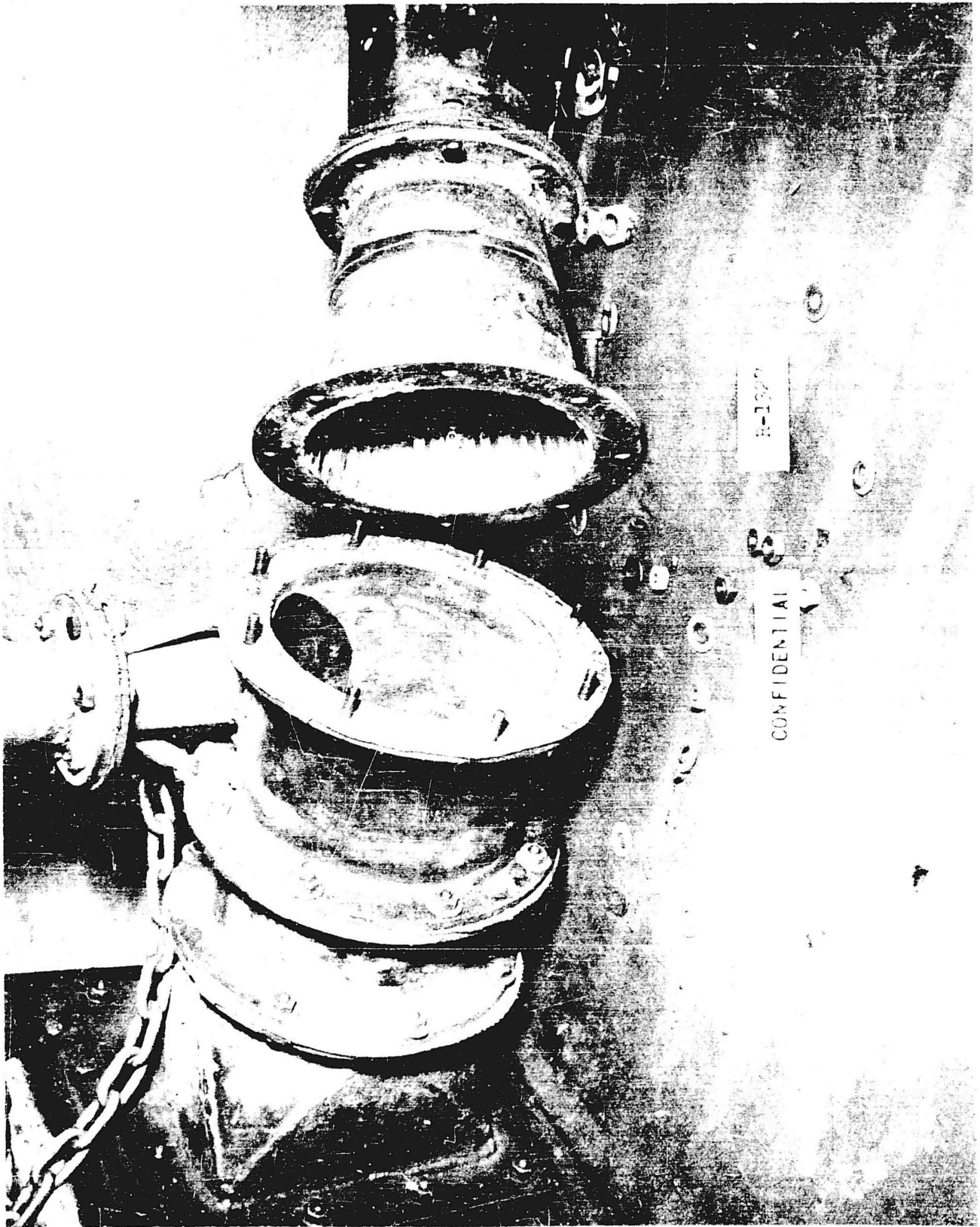
Report No. 1106



Most Advantageous Duct Shapes for Gasoline-Air Hydropulse

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Figure 57



Ball Transition Section, Showing Self-Spring Check Valves



Details of the Metal Contusion-Barrier Exhaust Valve for 111-57

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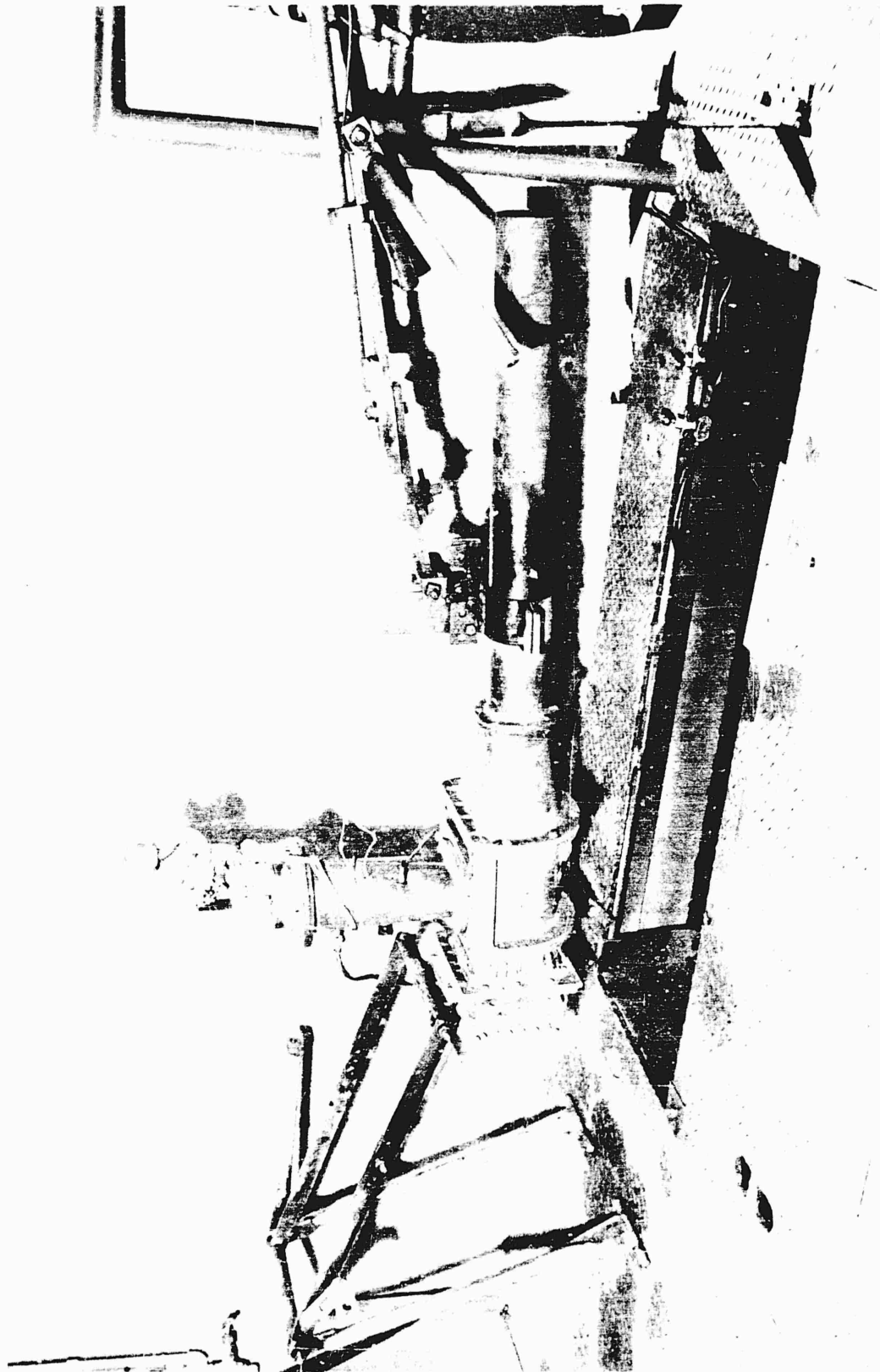
Report No. 1106



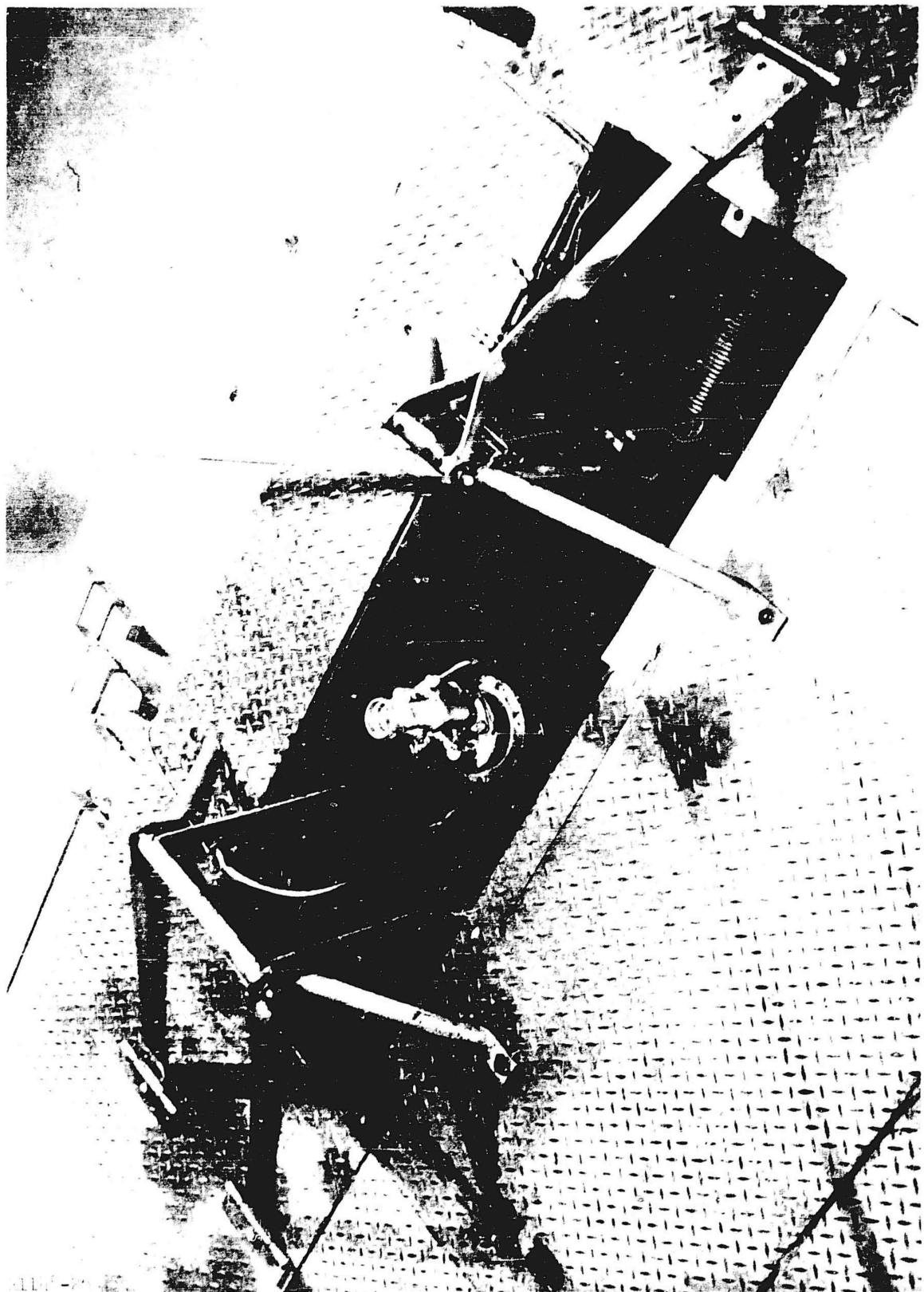
The Turbo-Magneto Ignition

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Figure 61



GAI-97 High-Thrust Motor



Parallelogram Thrust Stand for Static Testing of GAH Motors

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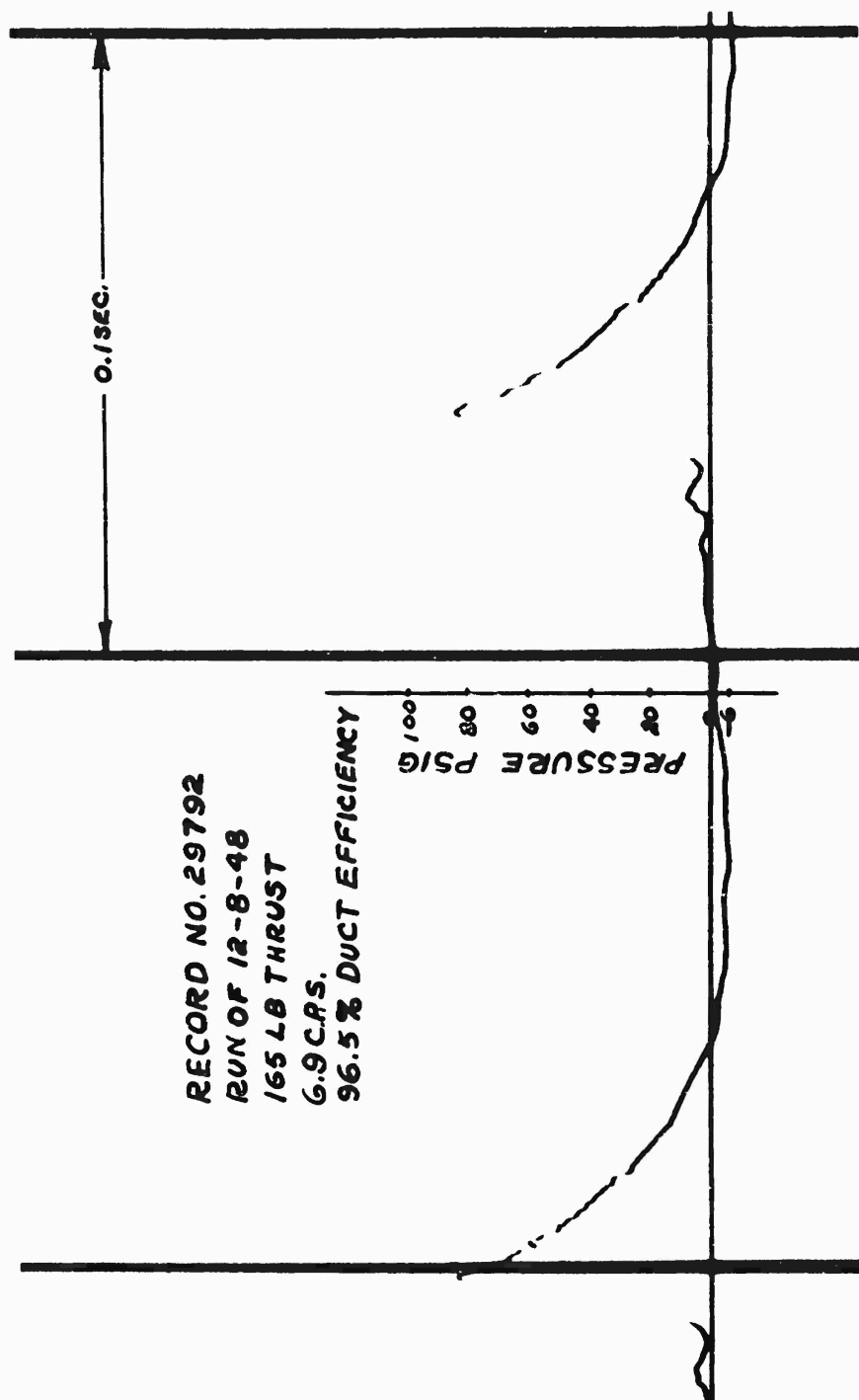
Skiff-Mounted GAH Testing in the 80-ft Ring Channel

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Figure 6h

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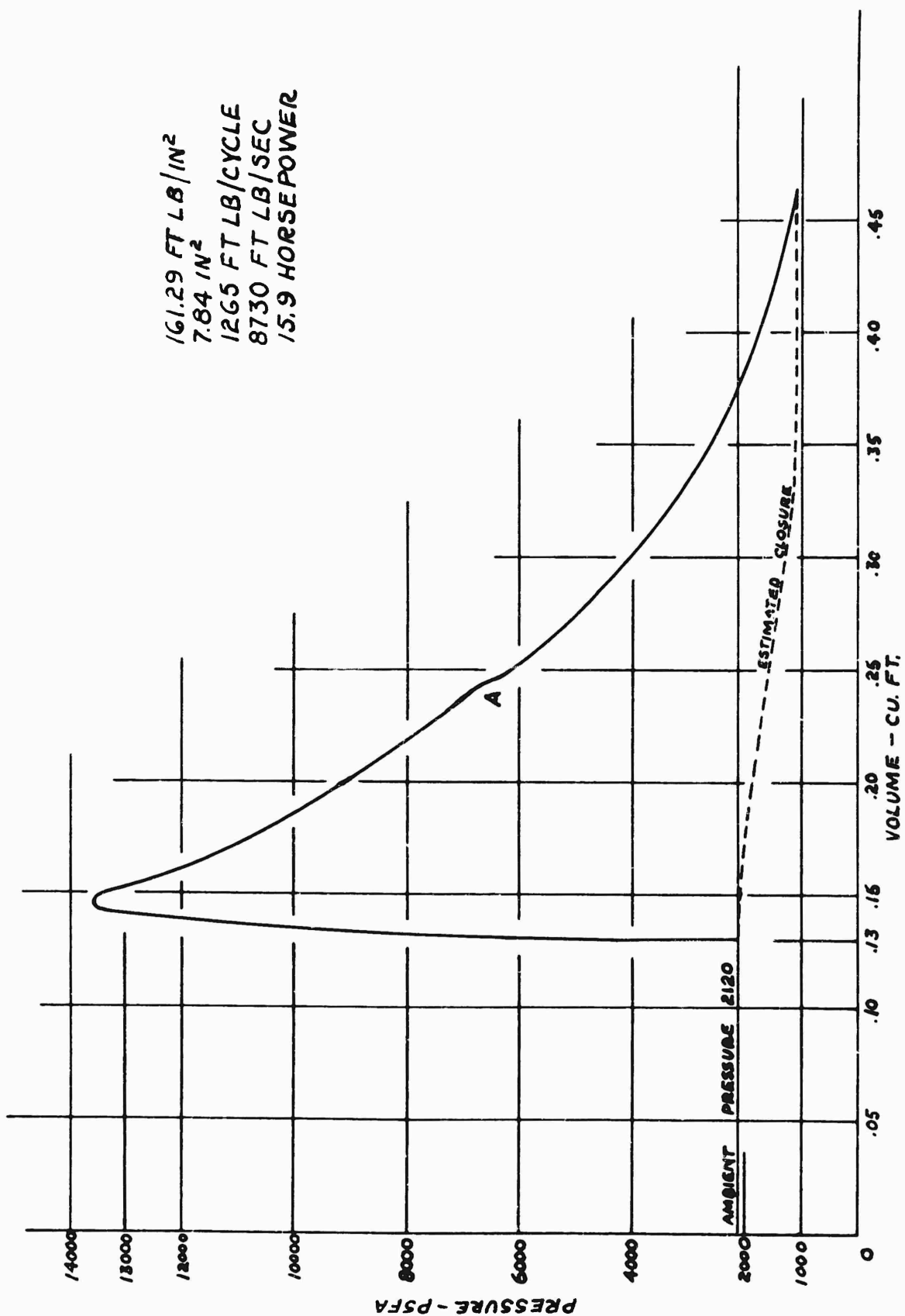
Report No. 1106



PRESSURE-TIME RECORD OF GAH-97

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Figure 65



PRESSURE - VOLUME DIAGRAM OF GAH-97

SEQUENCE OF EVENTS IN THE GASOLINE-AIR HYDROULSE

SCALE: $\frac{1}{16}$ " = 1" FREQUENCY: 5.8 c.p.s. STATIC TEST

CURVE NO. 4023 W.A. COVE 6-30-49

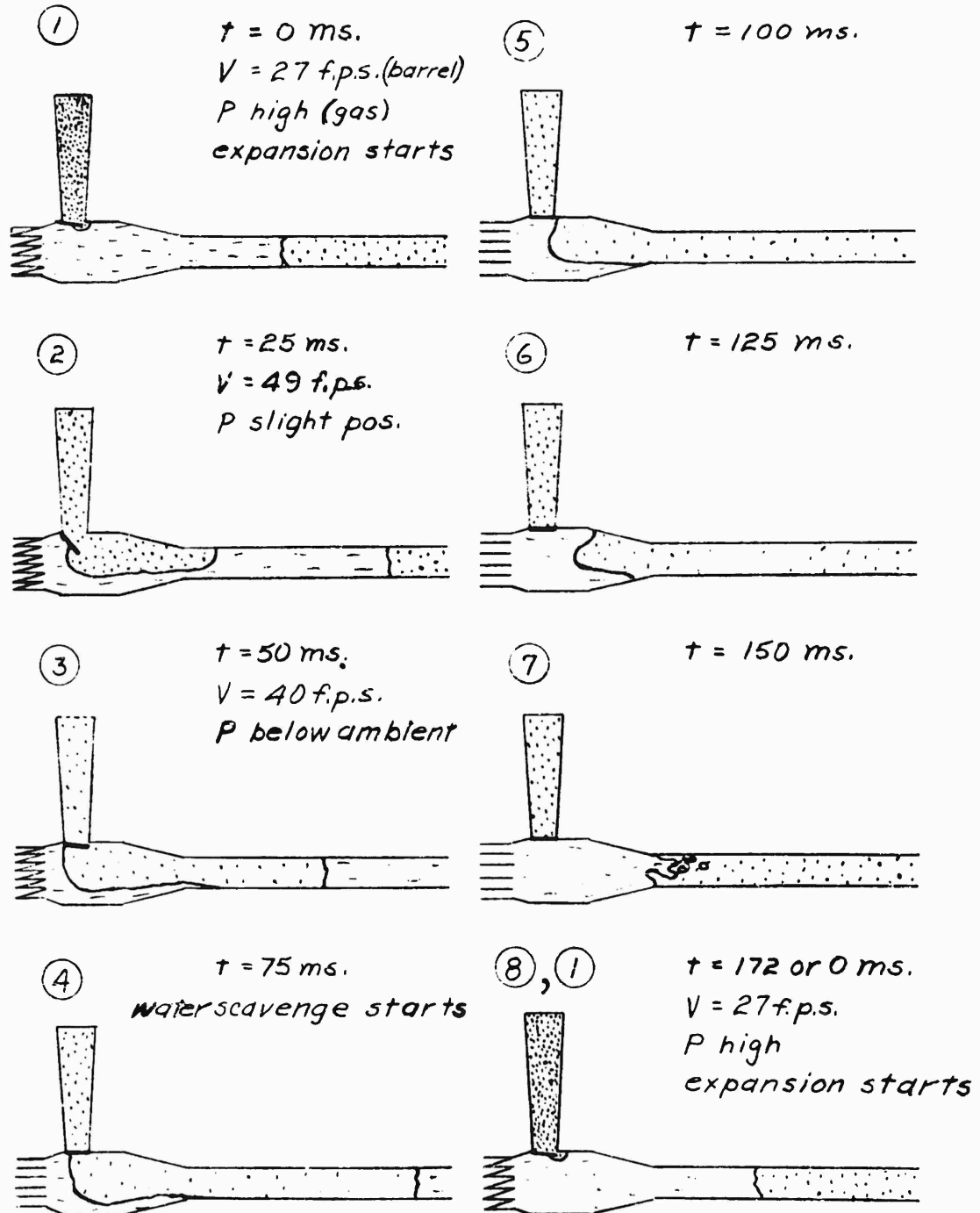
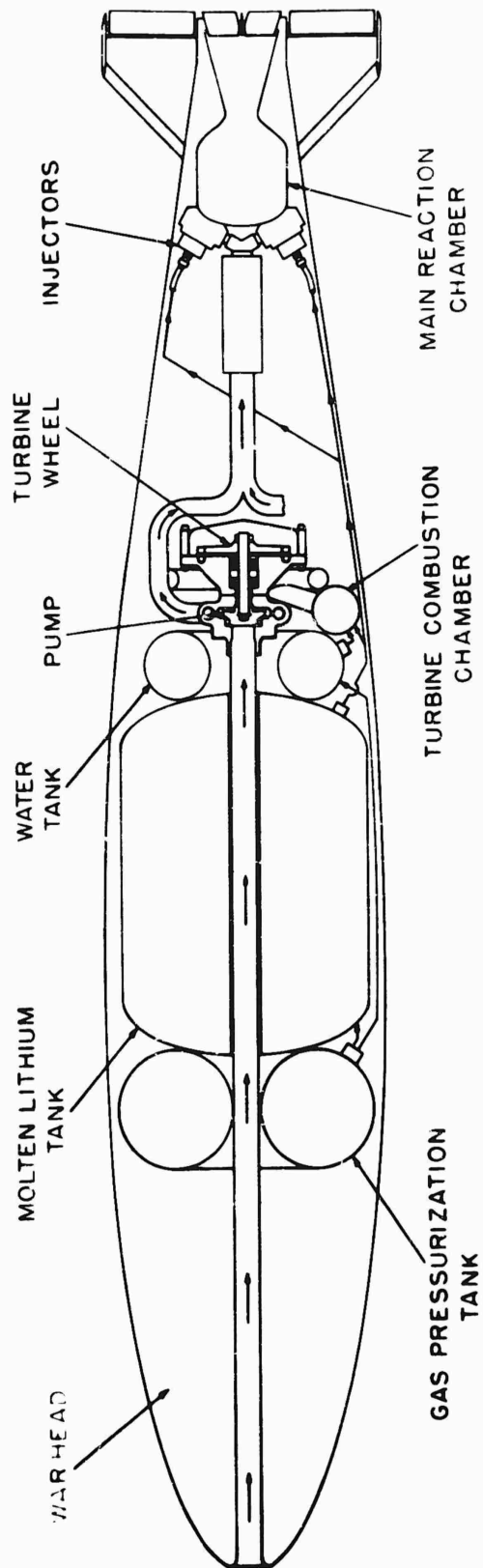
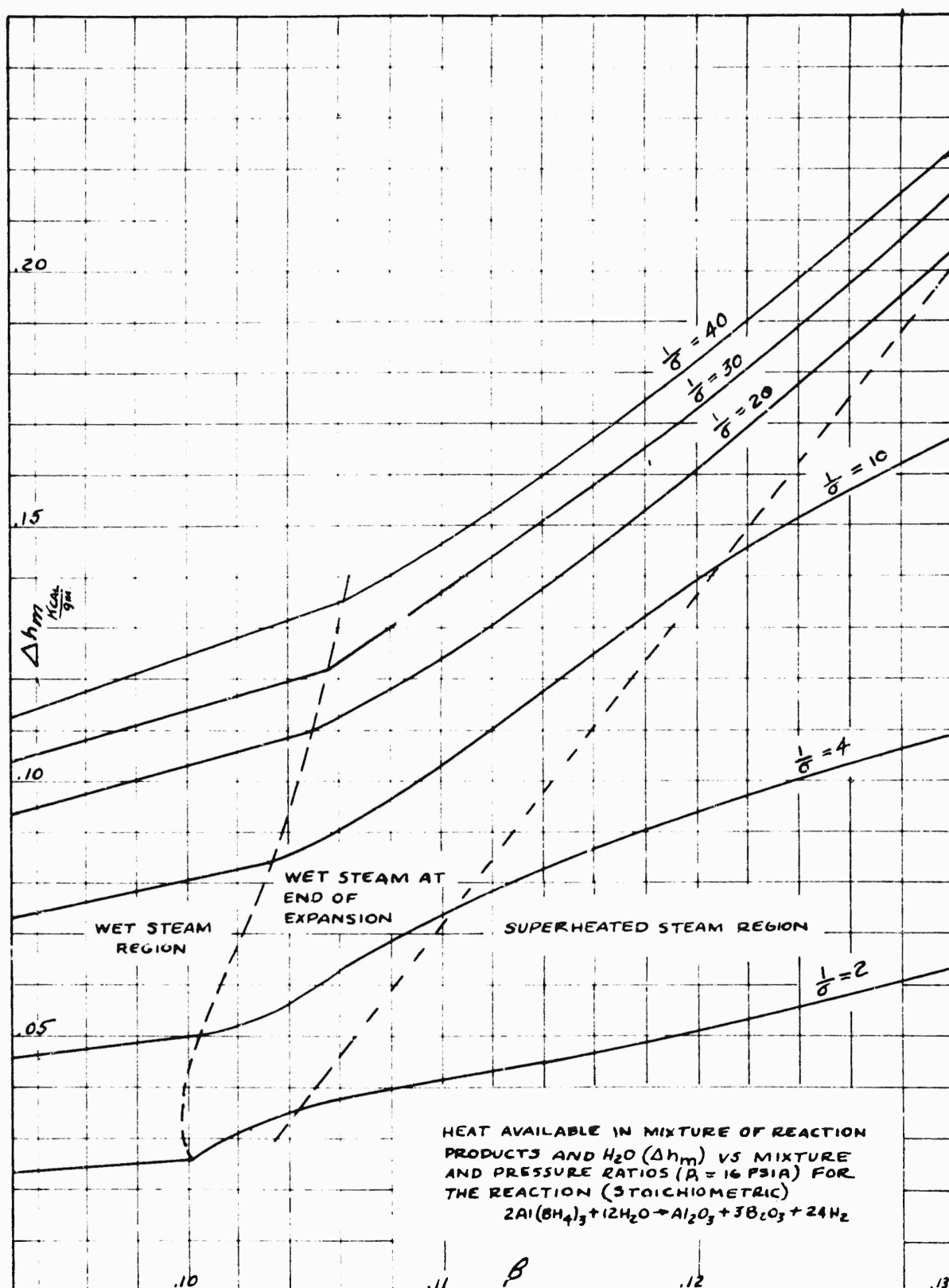


Figure 67



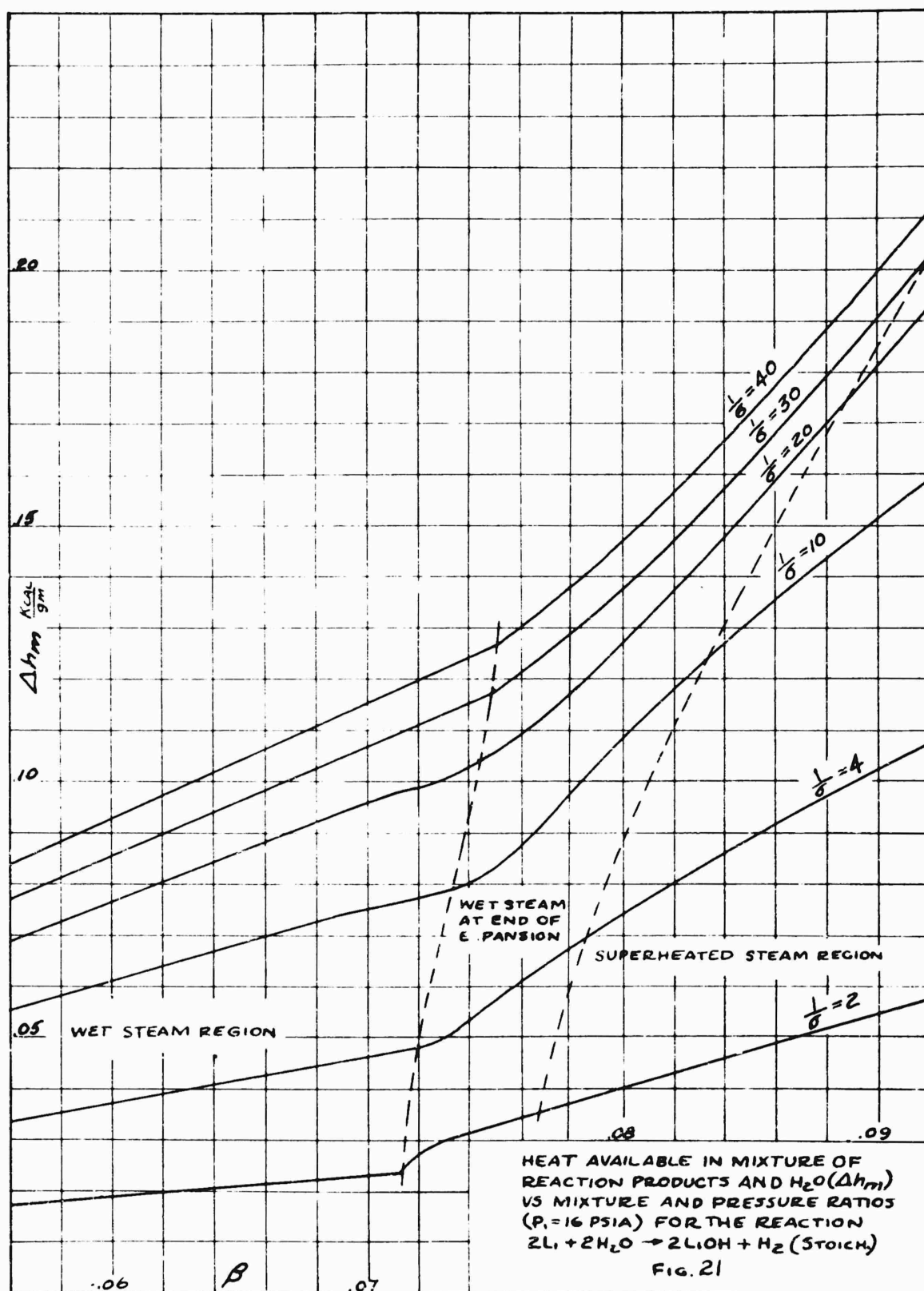
Hydroturbojet Propulsion System

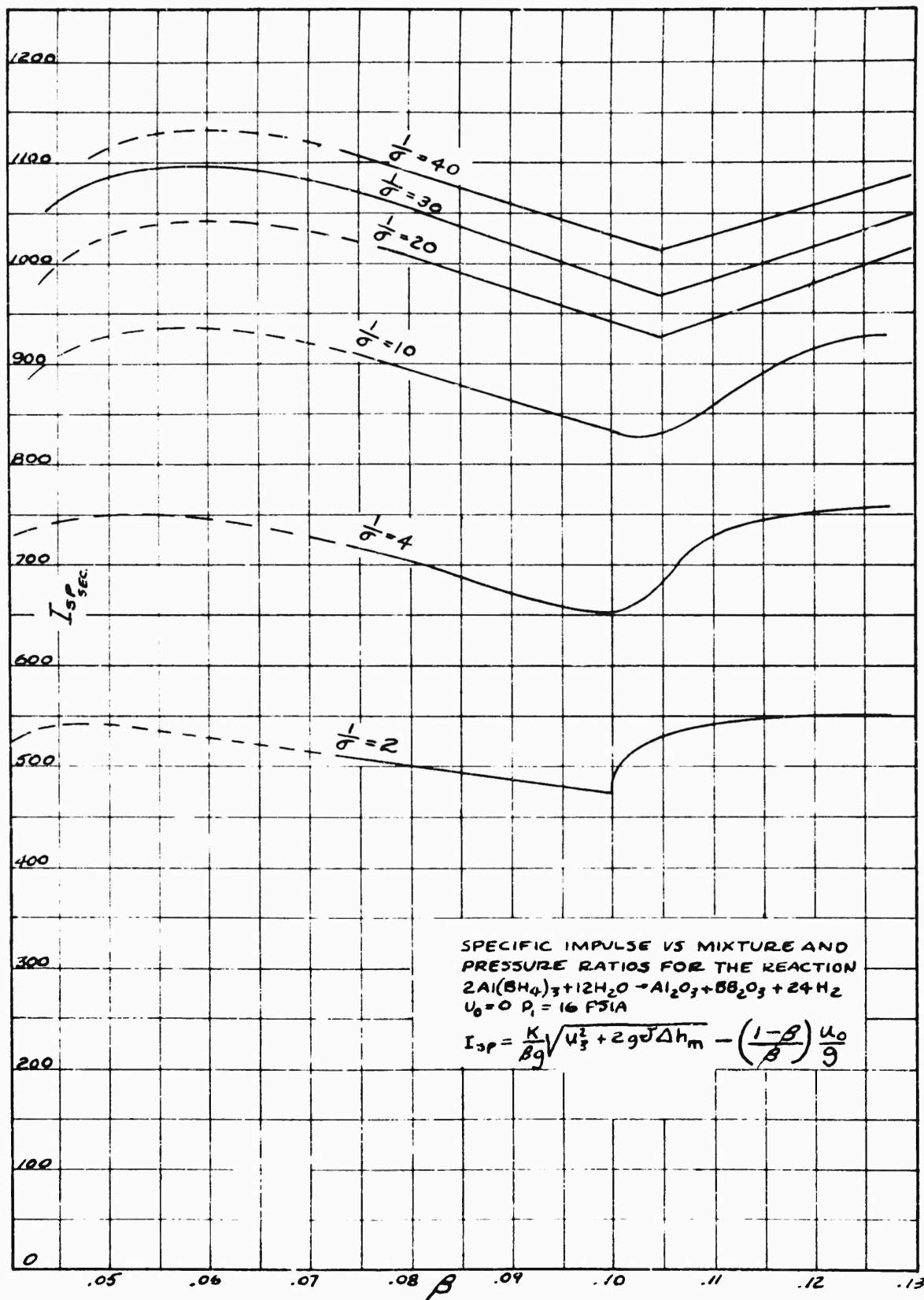
R249-20



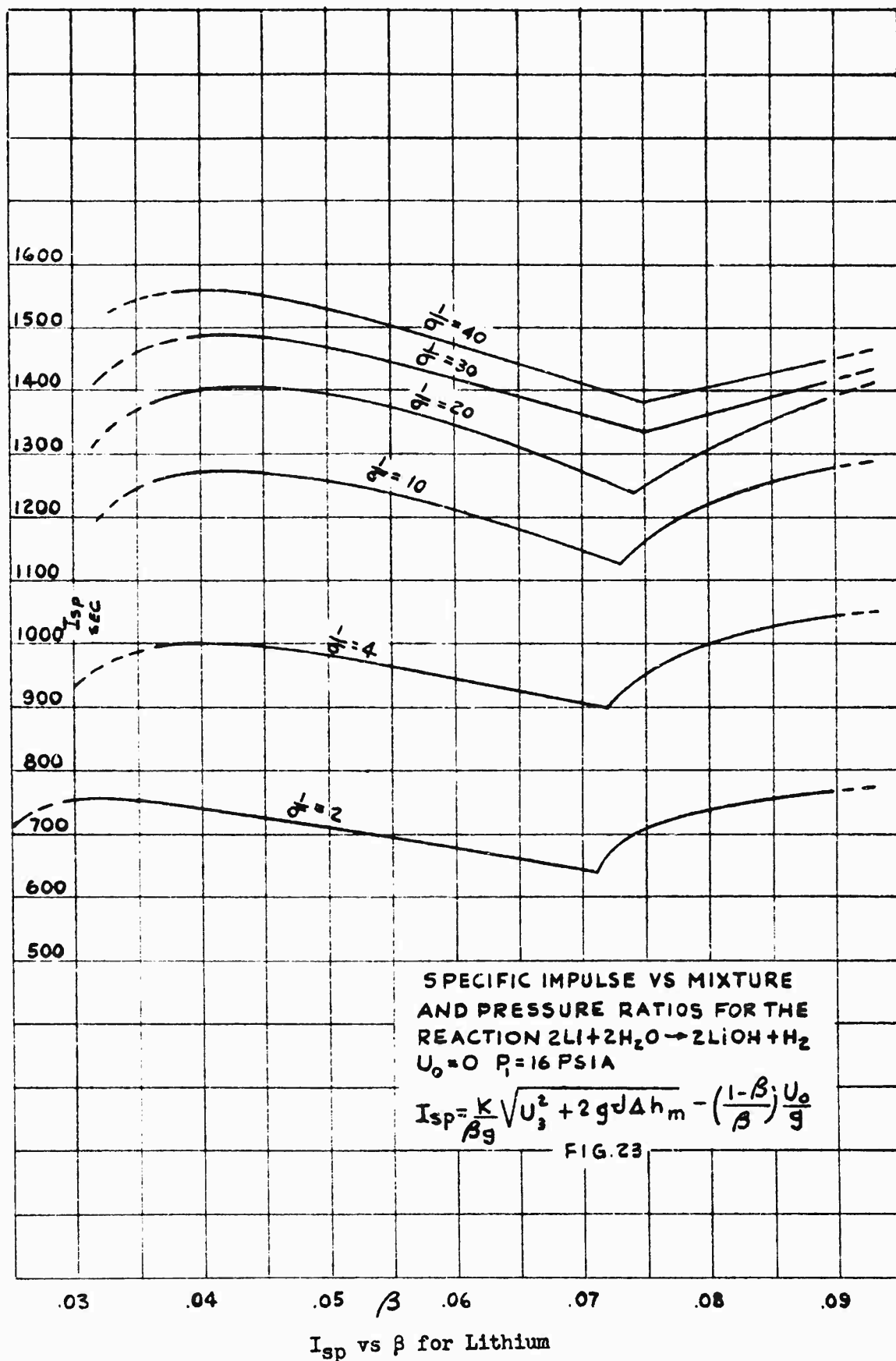
Δh_m vs β for Aluminum Borolyaride

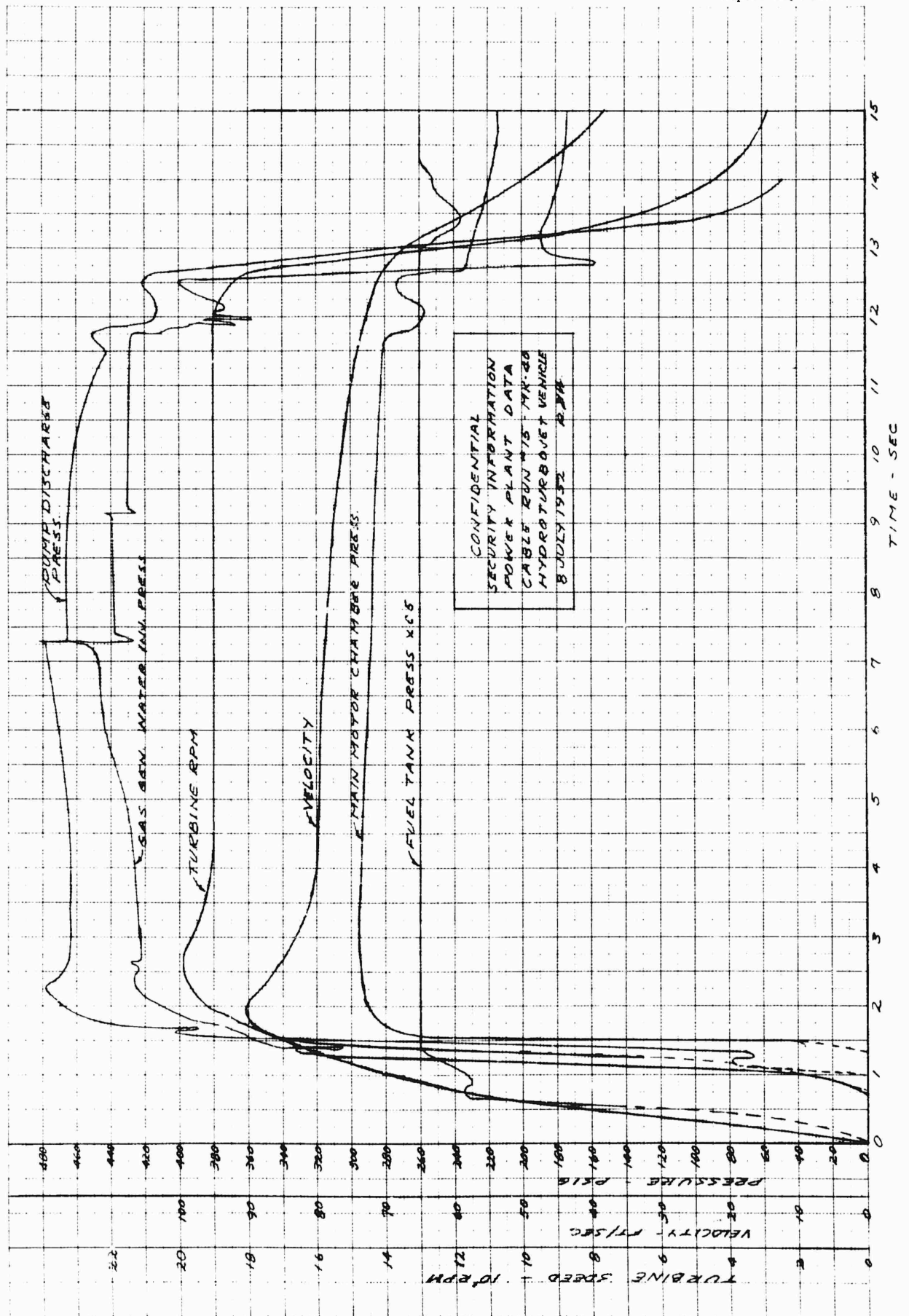
Figure 69

 Δh_m vs β for Lithium



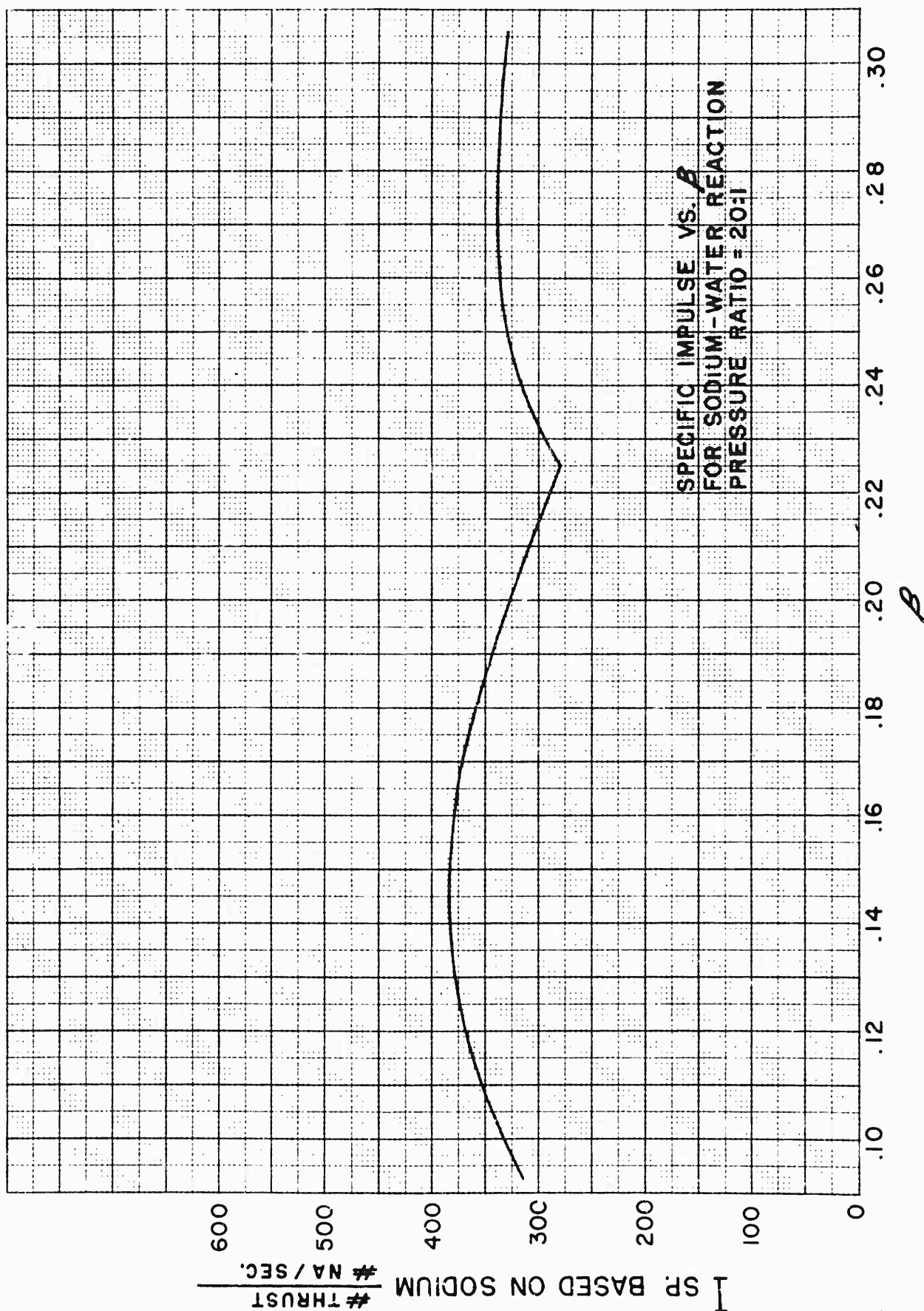
I_{sp} vs β for Aluminum Borohydride





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Report No. 1106

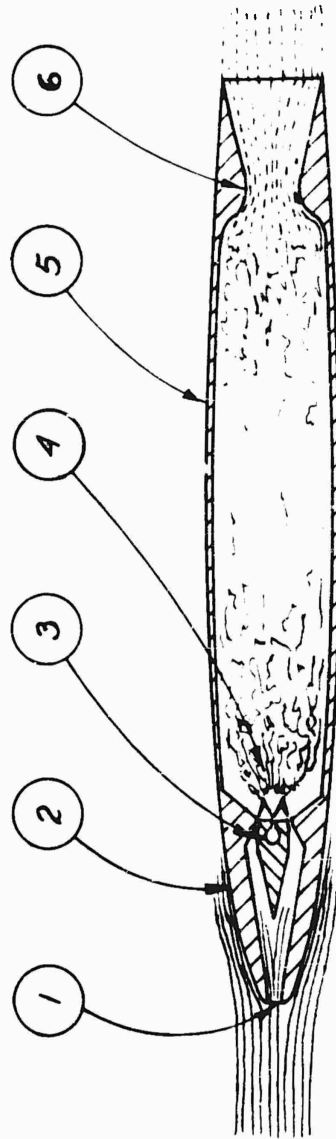


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Figure 74

CURVE NO. 4005

Higgins



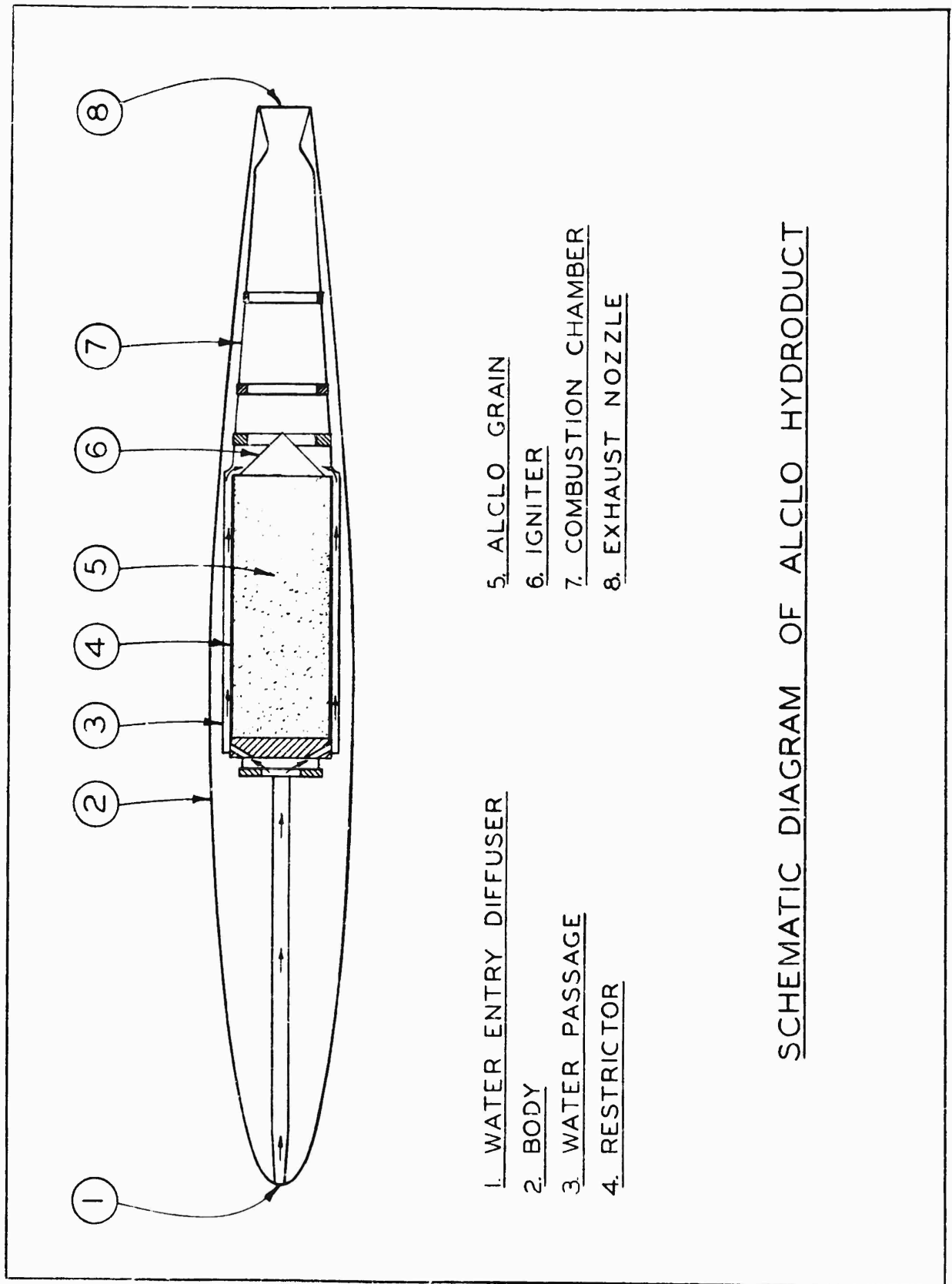
- 1 WATER ENTRANCE DIFFUSOR
- 2 NOSE SECTION
- 3 LITHIUM INJECTOR
- 4 REACTION ZONE
- 5 BODY
- 6 NOZZLE

HYDRODUCT NOMENCLATURE

CONFIDENTIAL

Report No. 1106

C-4151 12-23-52 BK EGL



SCHEMATIC DIAGRAM OF ALCLO HYDRODUCT

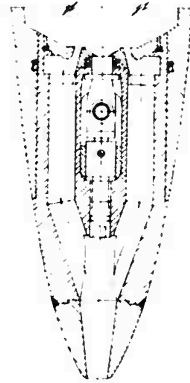
CONFIDENTIAL

Figure 76



4-in. Hydroduct with Tail Fairing in Place

R1248-153



SECTION E-E

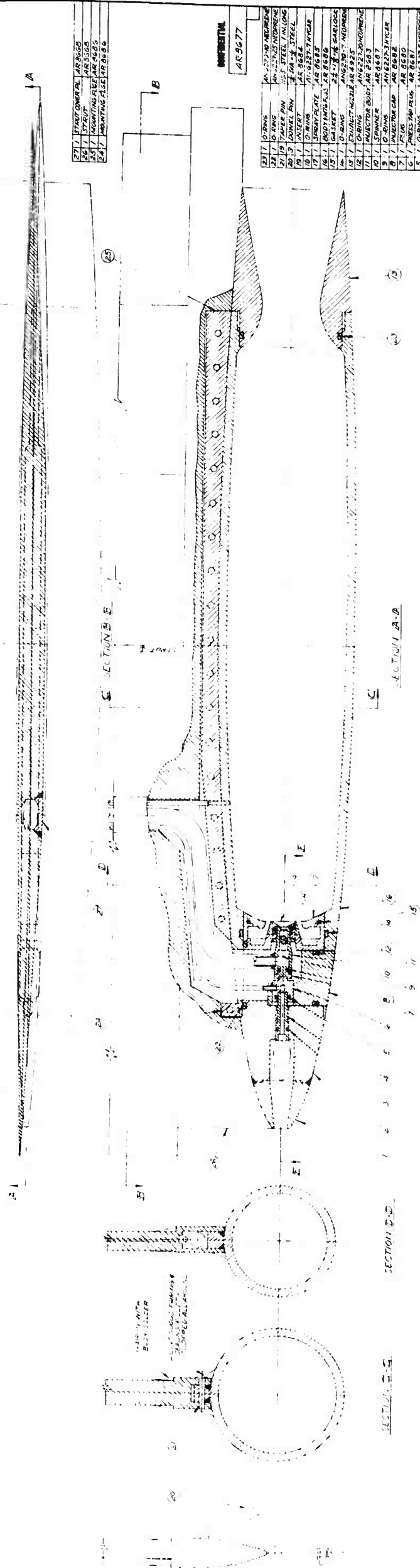


TABLE 1

231	1	INJECTOR BODY	AR 8677
232	1	INJECTOR PIN	AR 8677
233	1	INJECTOR PLATE	AR 8677
234	1	INJECTOR PLATE	AR 8677
235	1	INJECTOR PLATE	AR 8677

TABLE 2

236	1	INJECTOR BODY	AR 8677
237	1	INJECTOR PIN	AR 8677
238	1	INJECTOR PLATE	AR 8677
239	1	INJECTOR PLATE	AR 8677
240	1	INJECTOR PLATE	AR 8677

TABLE 3

241	1	INJECTOR BODY	AR 8677
242	1	INJECTOR PIN	AR 8677
243	1	INJECTOR PLATE	AR 8677
244	1	INJECTOR PLATE	AR 8677
245	1	INJECTOR PLATE	AR 8677

TABLE 4

ITEM NO.	QTY	DESCRIPTION	UNIT	REMARKS
246	1	INJECTOR BODY	AR 8677	
247	1	INJECTOR PIN	AR 8677	
248	1	INJECTOR PLATE	AR 8677	
249	1	INJECTOR PLATE	AR 8677	
250	1	INJECTOR PLATE	AR 8677	

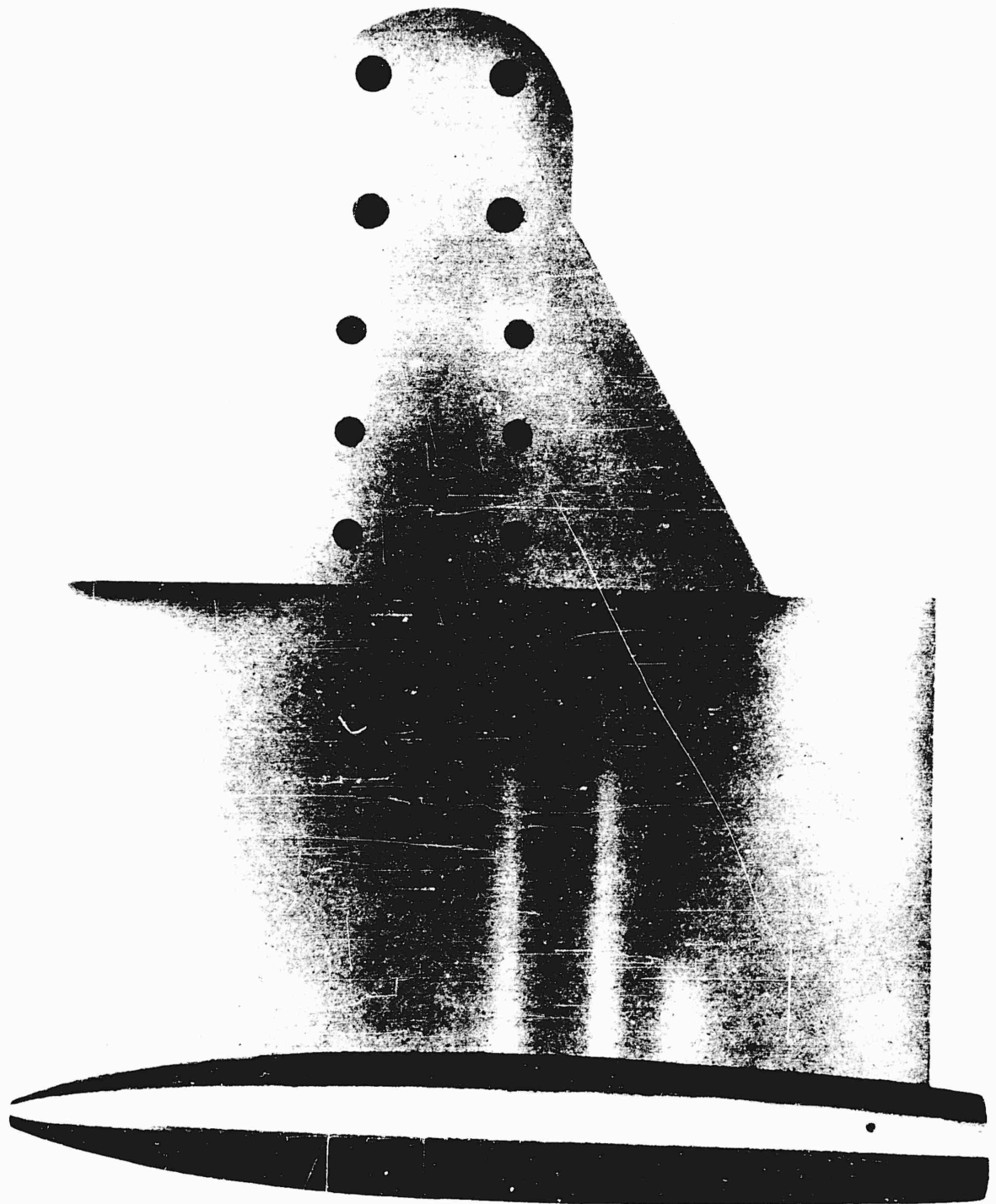
NOTES: 1. DRILL AND REAM FOR CONE AND TAPER PINS. 2. ASSEMBLY.

Figure 78



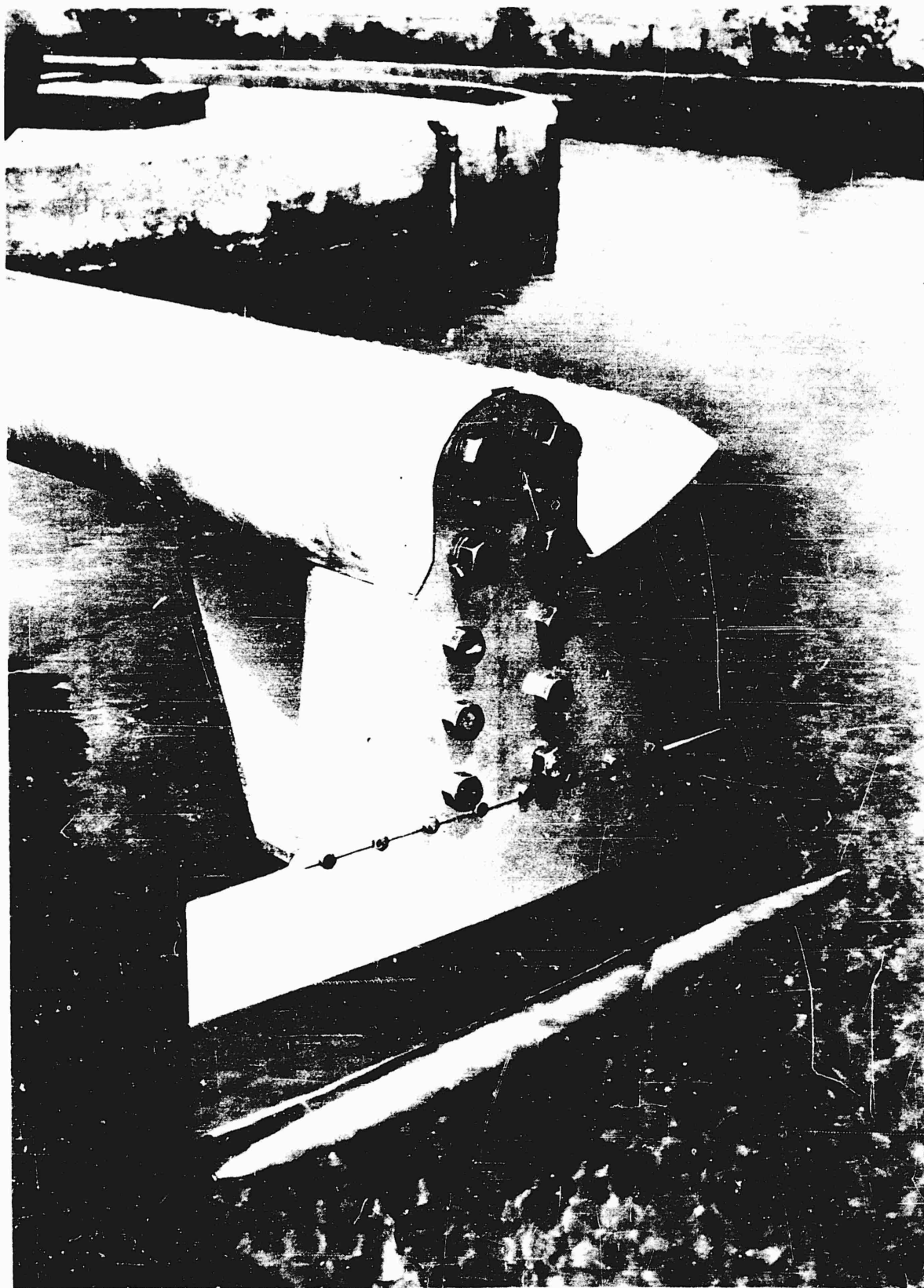
Components of the 4-in. Hydroduct Mark I

11248-132



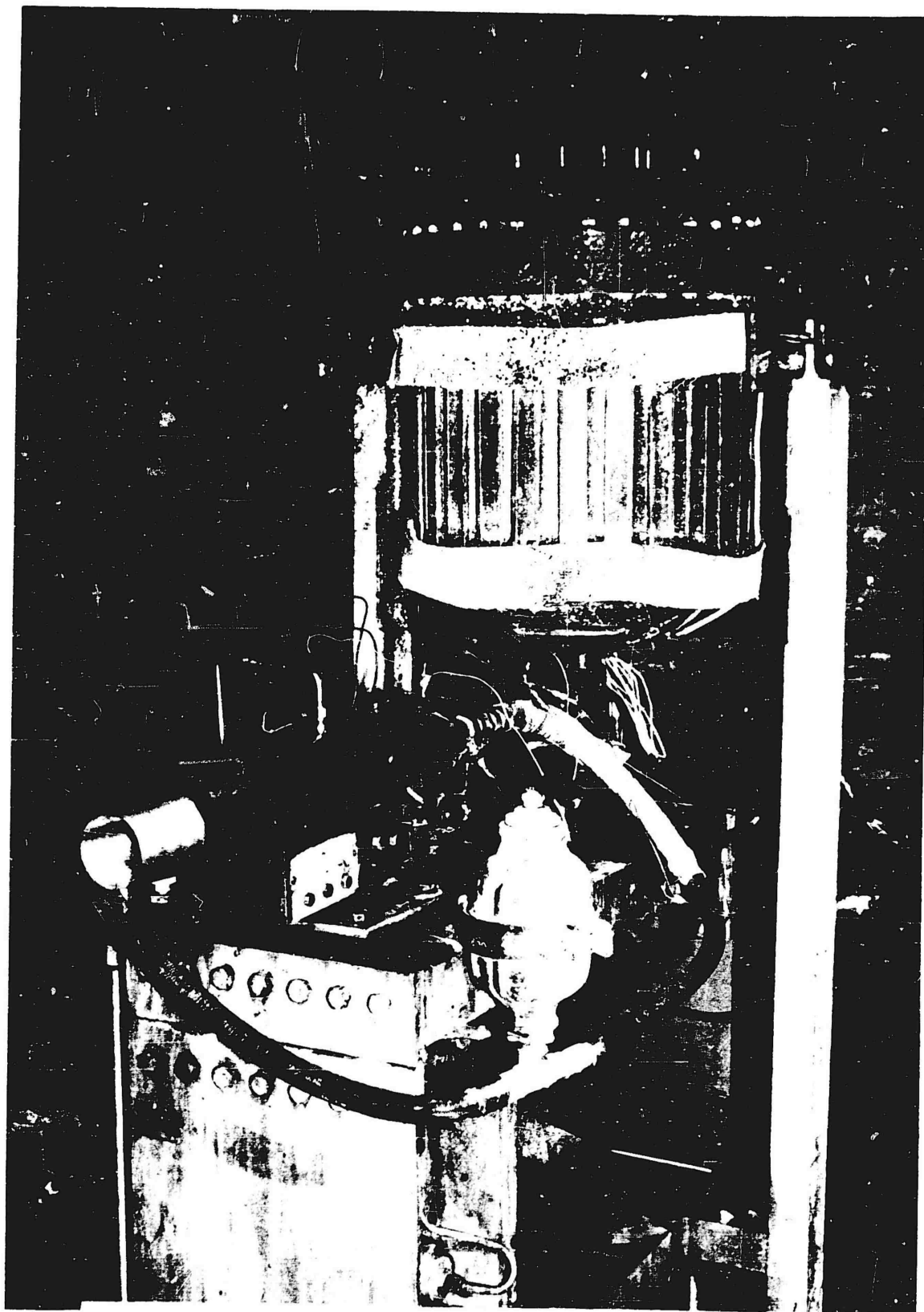
PL49-63

1/4-in. Hydroduct with Suspending Strut Attached



Hydroduct Mark II in Position for Drag Testing

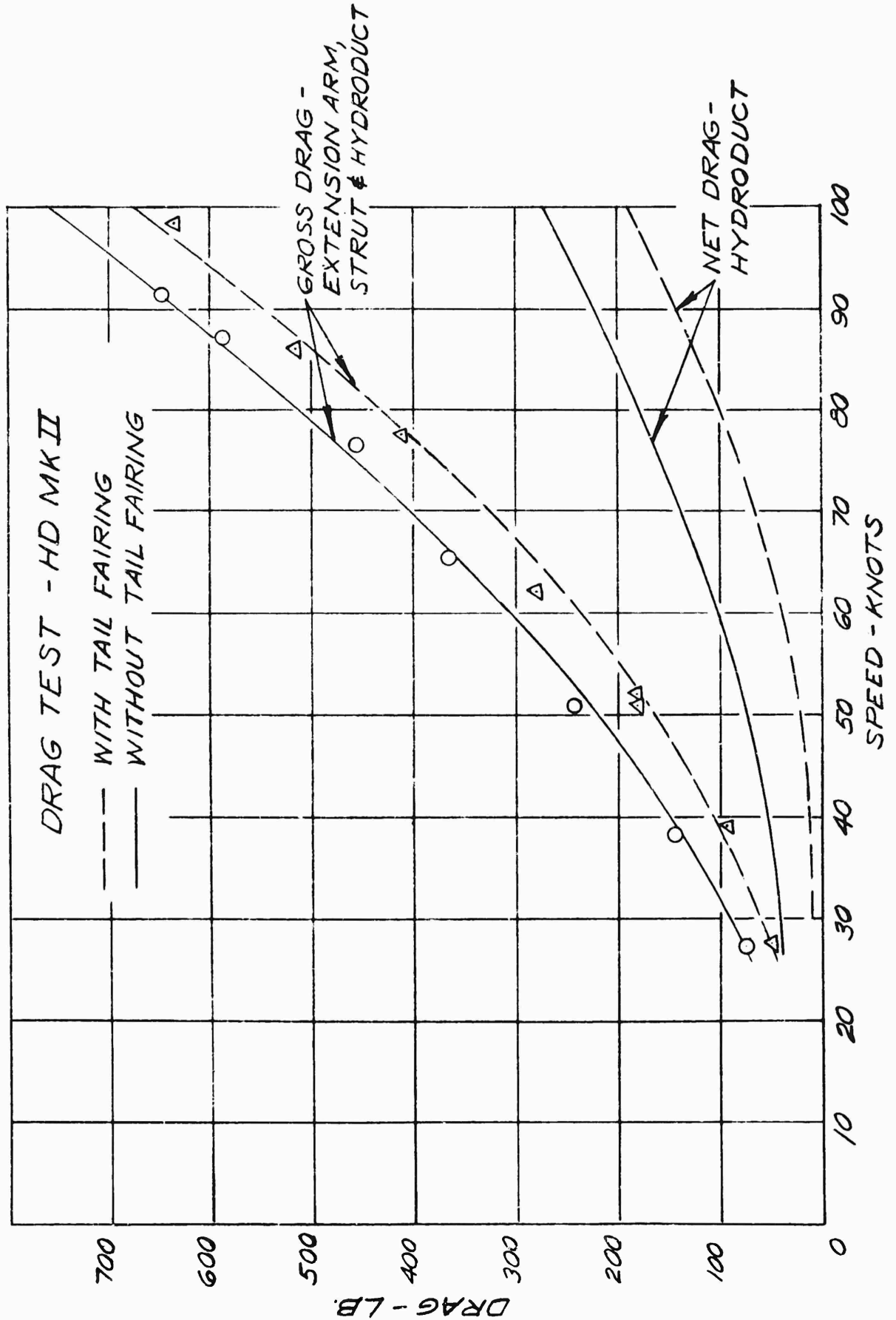
Figure 81



R349-8

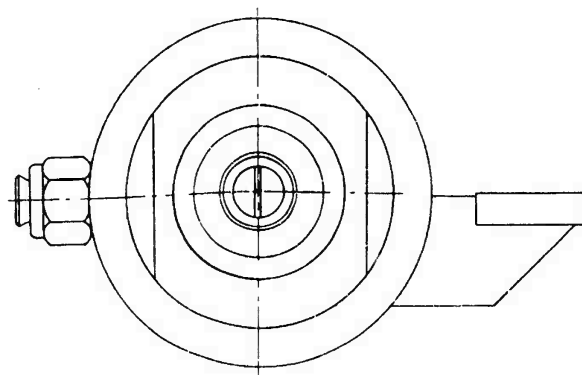
4-in. Hydroduct Mark I, Static Test Pit Setup

CURVE NO. 4075 1-12-50 EGL



Report No. 1106

Report No. 1106



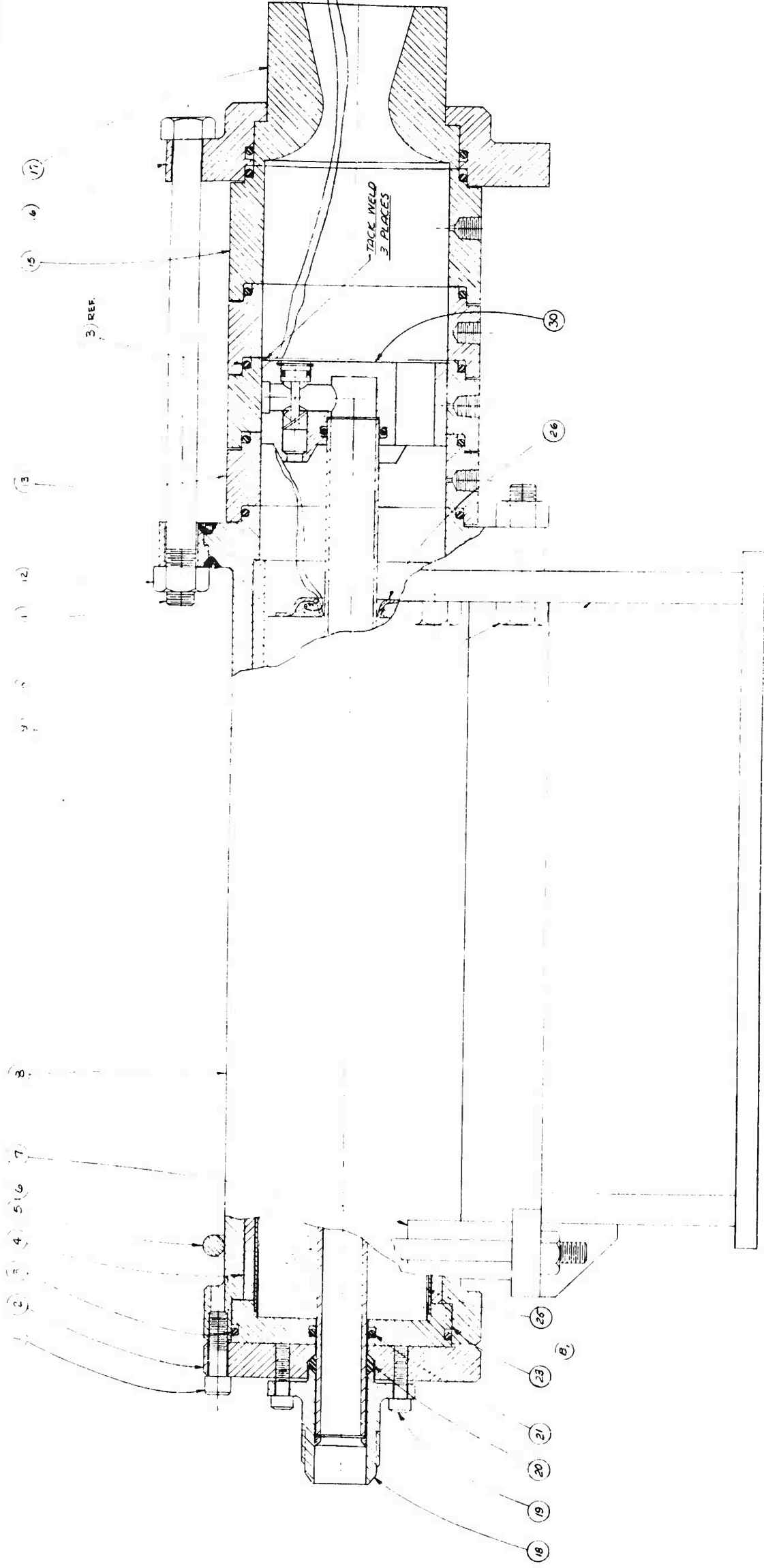
AP8928

[illegible]

NOTES : Remove all burrs and sharp edges

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Figure 58



ATTN	DATE	CHANGE	BY	COMP
A	10-5-51	4 14 1 10 INVR 249 ADDED	BRK	F.R.
		25 26 REMISED		
B	11/5/51	TR INVR 25 ADDED	NAM	
		ADDED (9 60) WAS 1 RECD	JMC	
C	11-5-52	DELETED		
		DELETED 19, 27, 29, 29		

30	1	INJECTOR	AR 8230
29	1	TURBULATOR	AR 8229
28	1	SOCKET HO	STL, 1/4-20NF-62LG
27	1	GASKET	AR 8227
26	1	CUP IGNITER	AR 8216
25	1	PROPELLANT CHARGE	
24	4	SOCKET HO SET SCREW	STL, 1/4-20NF-62LG
23	1	CAP	AR 8208
22	1	SHIM	35 TURNING SOCKET HO 20-50
21	2	O RING	SIEVE PAPER #17
20	1	GASKET	AR 8218-2
19	4	SOCKET HO	STL, 1/4-20NF-62LG
18	1	FLANGE	AR 8218-1
17	1	NOZZLE	AR 8953-9
16	1	FLANGE	AR 8954-4

AR 8952	C
---------	---

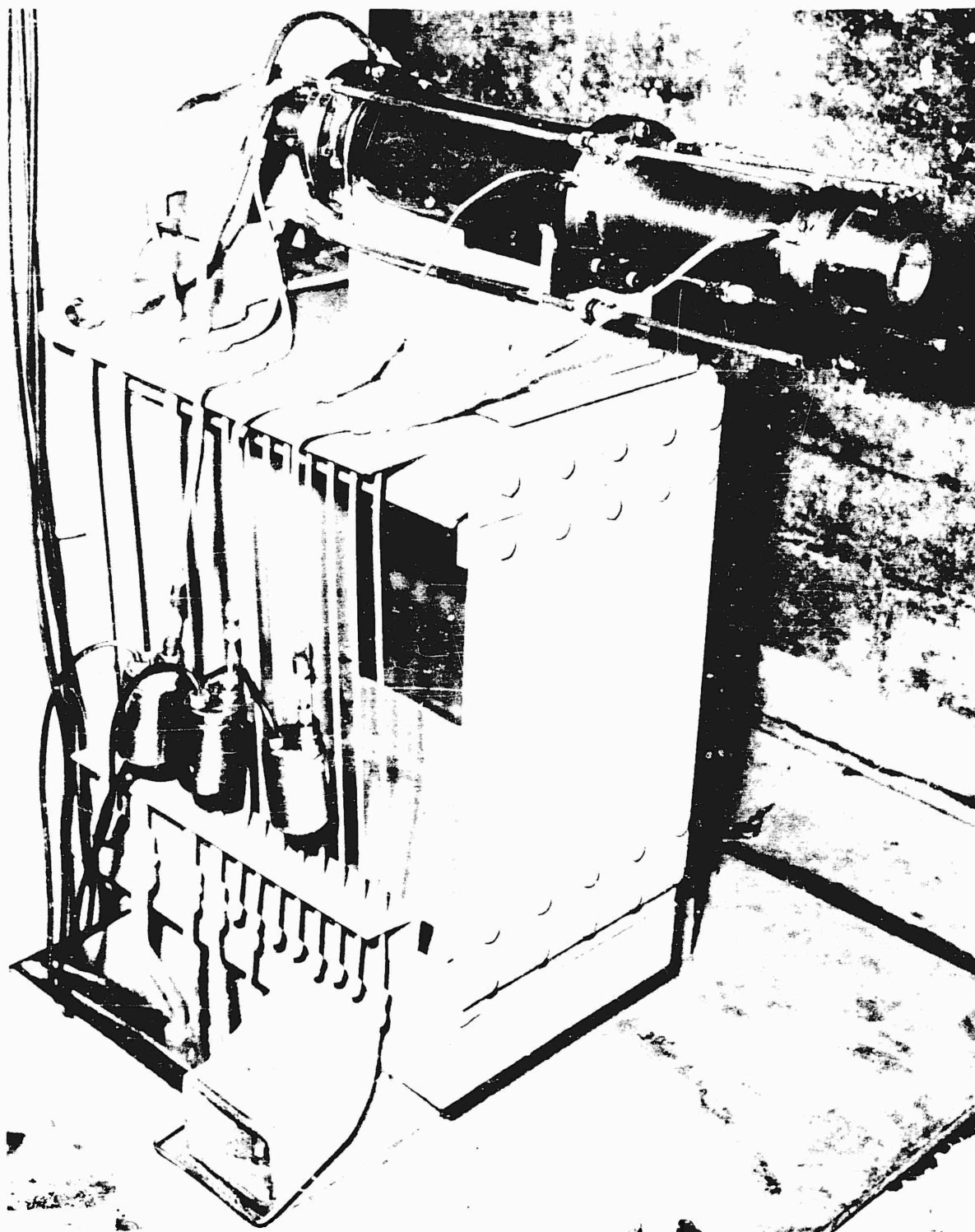
15	1	SPACER	AR 8954-2
14	1	INJECTOR	AR 8918-1
13	2	SPACER	AR 8954-1
12	1	HEX. NUT	STL 2-13 N.C.
11	6	HEX. HEAD BOLT	STL 2-13 N.C. X 8.00 L6
10	3	HEX. HEAD BOLT	STL 2-13 N.C. X 1.78 L6
9	1	MTR. MOUNT	AR 8955-1
8	1	CHAMBER	AR 8953-1
7	1	BLOCK	AR 8955-3
6	2	HEX. NUT	STL 2-16 L6 C.
5	1	'U' BOLT	AR 8955-2
4	1	LINE R	STL 3.38 0.02.300.0A 28.5 L6
3	7	'O' RING	MAT. HYCAR H-209-70
2	1	END PLATE	STL 2-18 N.C. X 4.30 L6
1	6	SECRET HEAD	STL 2-18 N.C. X 1.00 L6

[illegible]

Subject: English Date: 11/01/2023

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Report No. 1106

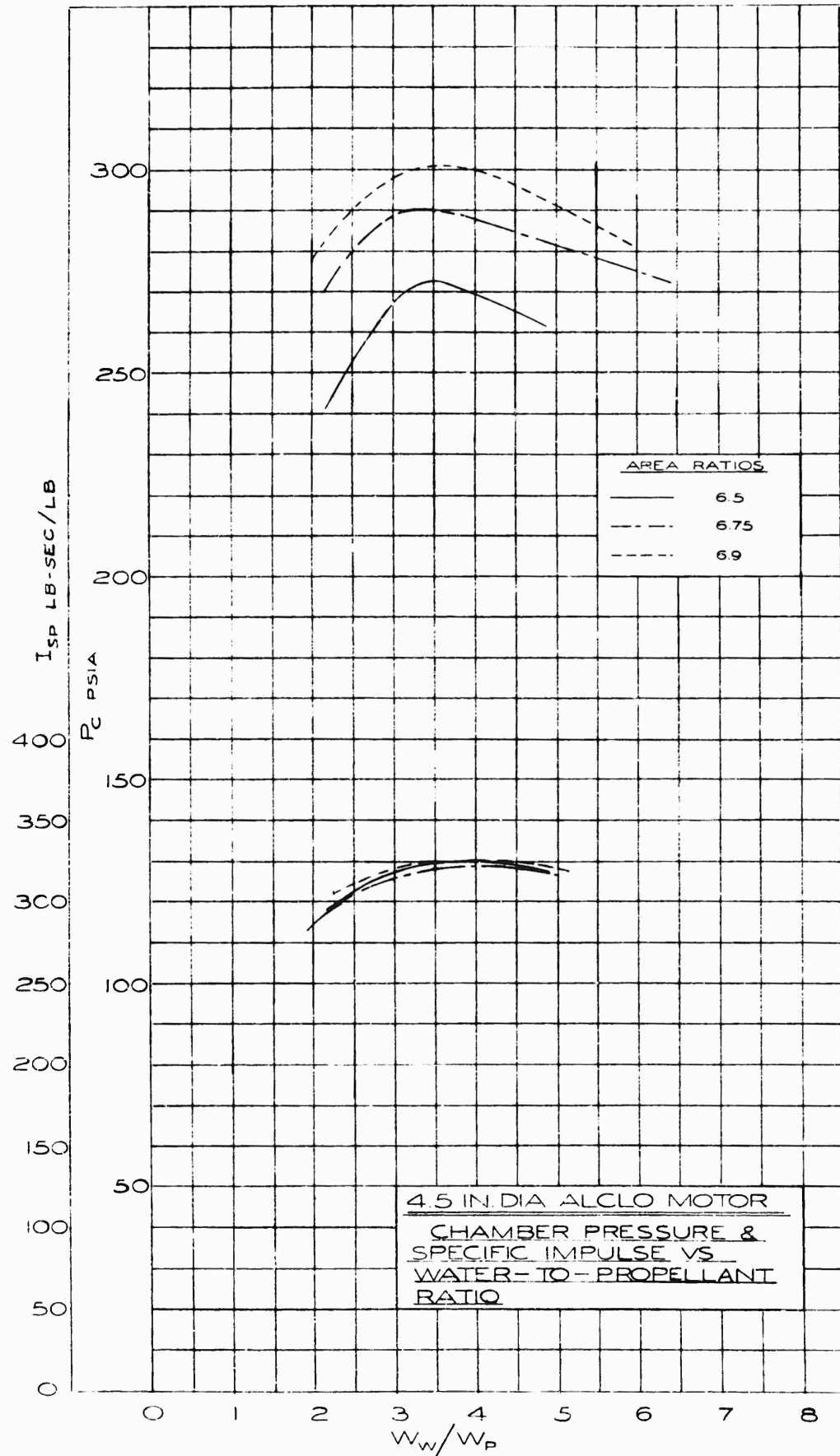


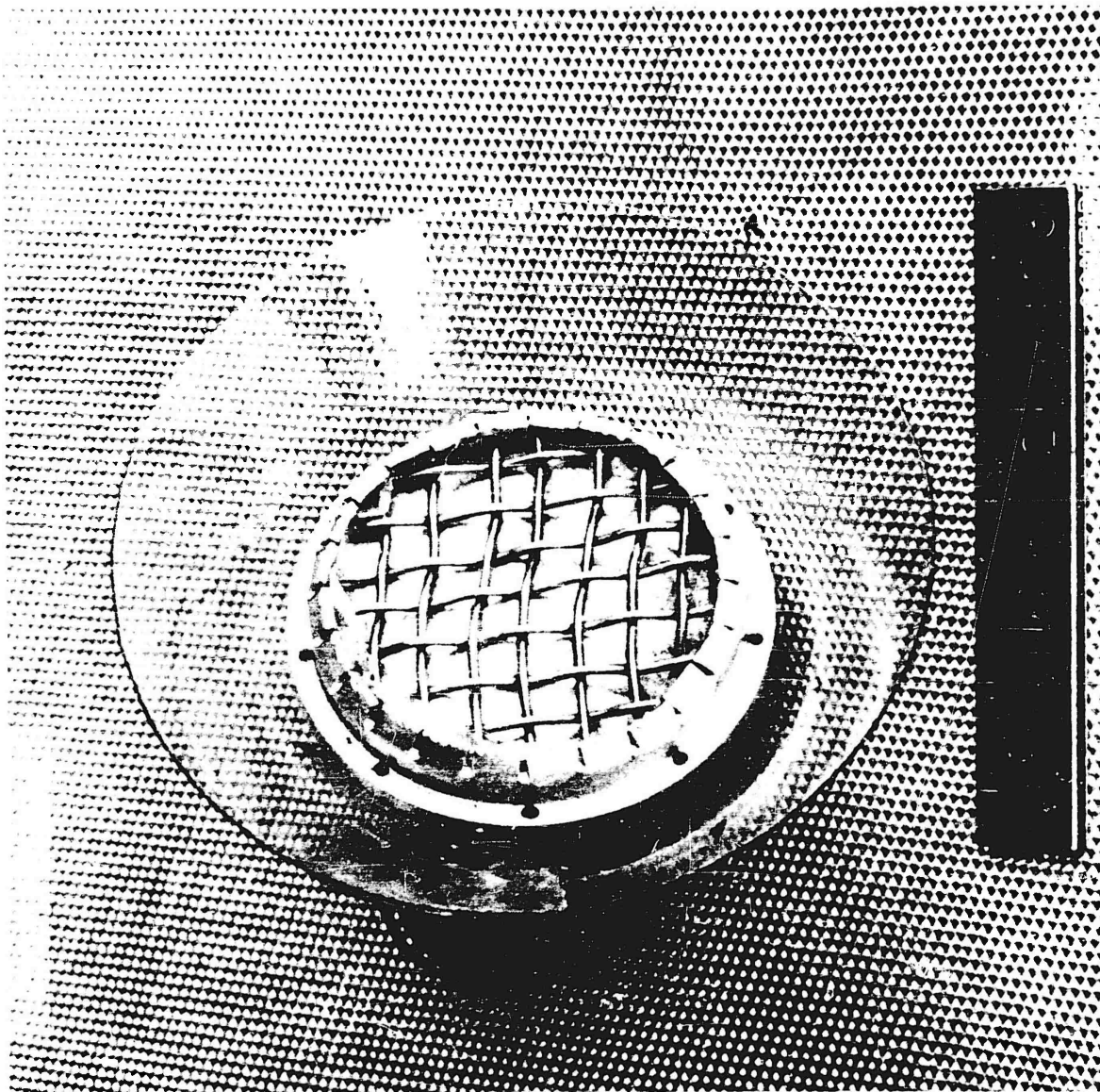
Alc10 Motor Setup for Testing in Static Test Pit

Figure 83

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CURVE NO. 4127





Stanc-Off Igniter Mark II

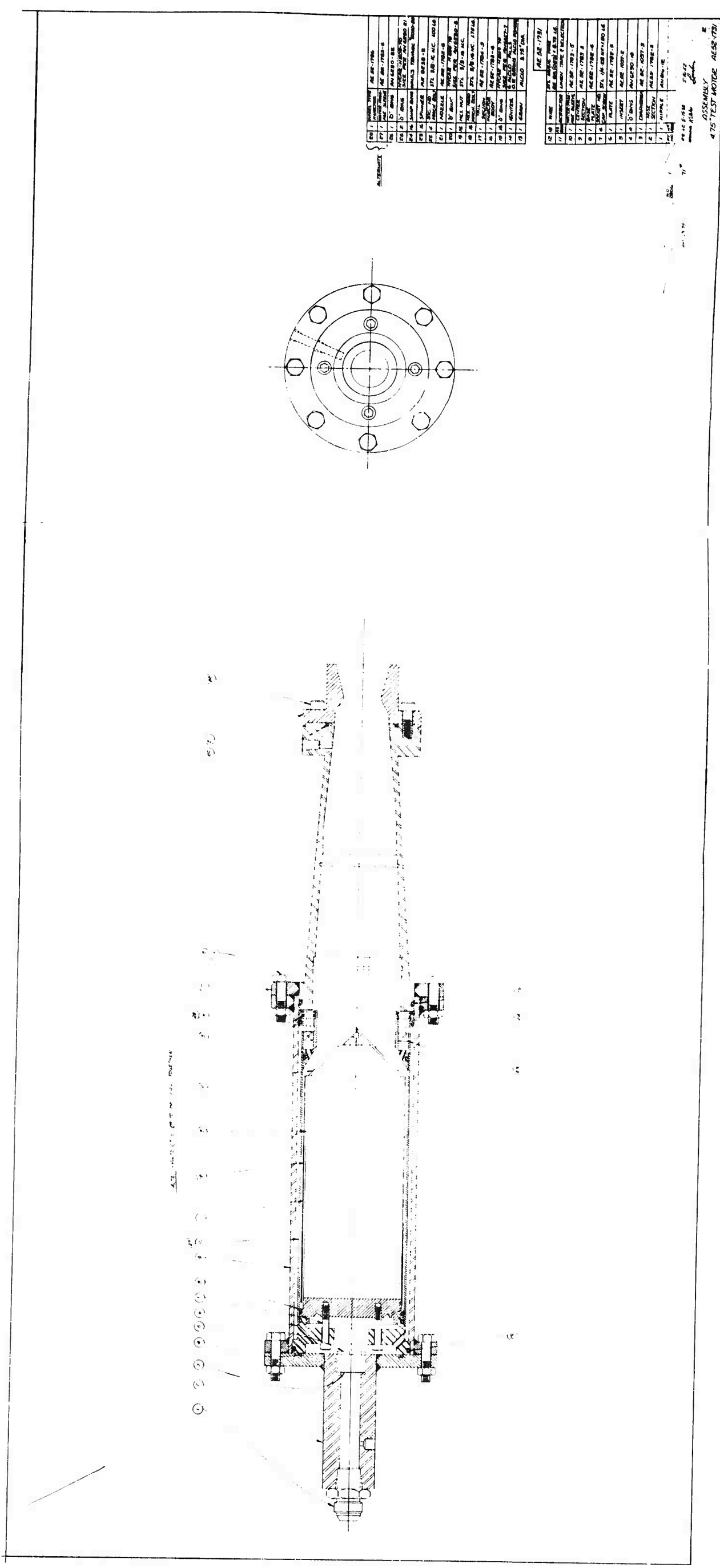
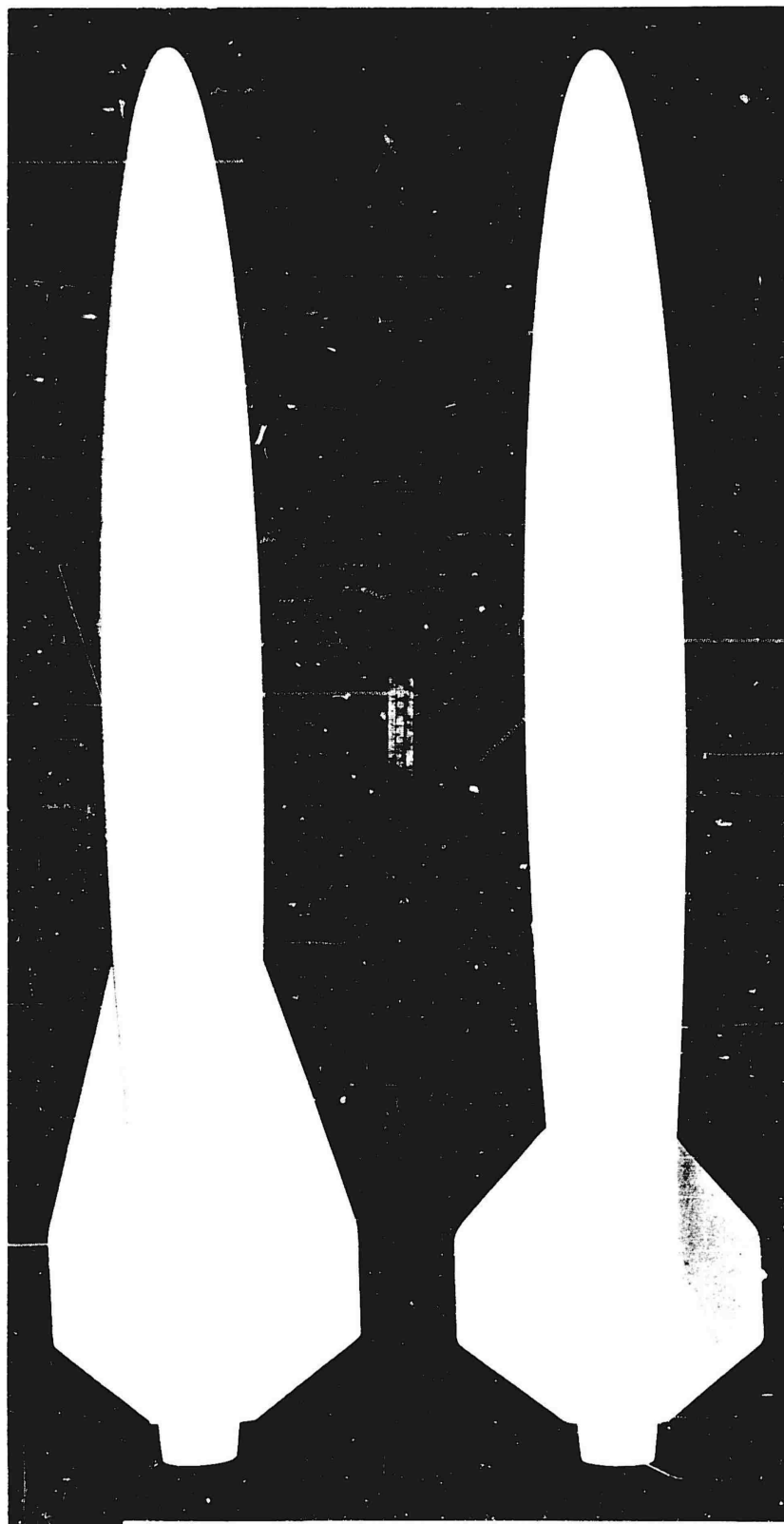


Figure 91



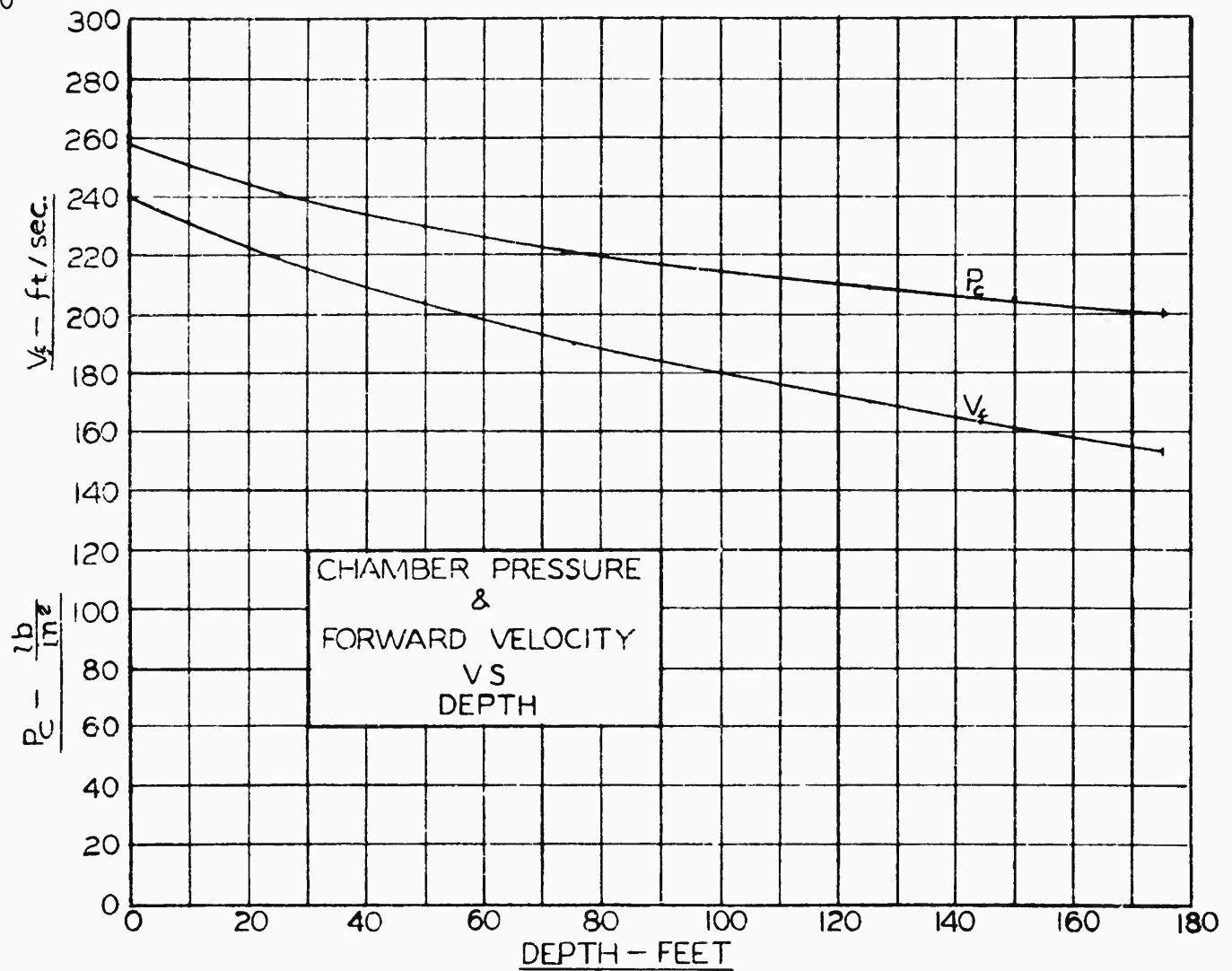
Comparative View of Test Vehicles with Type I and Type II Fins

11-2-63

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Report No. 1106

CURVE NO. 4116



PERFORMANCE OF
4.5 IN.DIA. ALCLO HYDRODUCT

Figure 94

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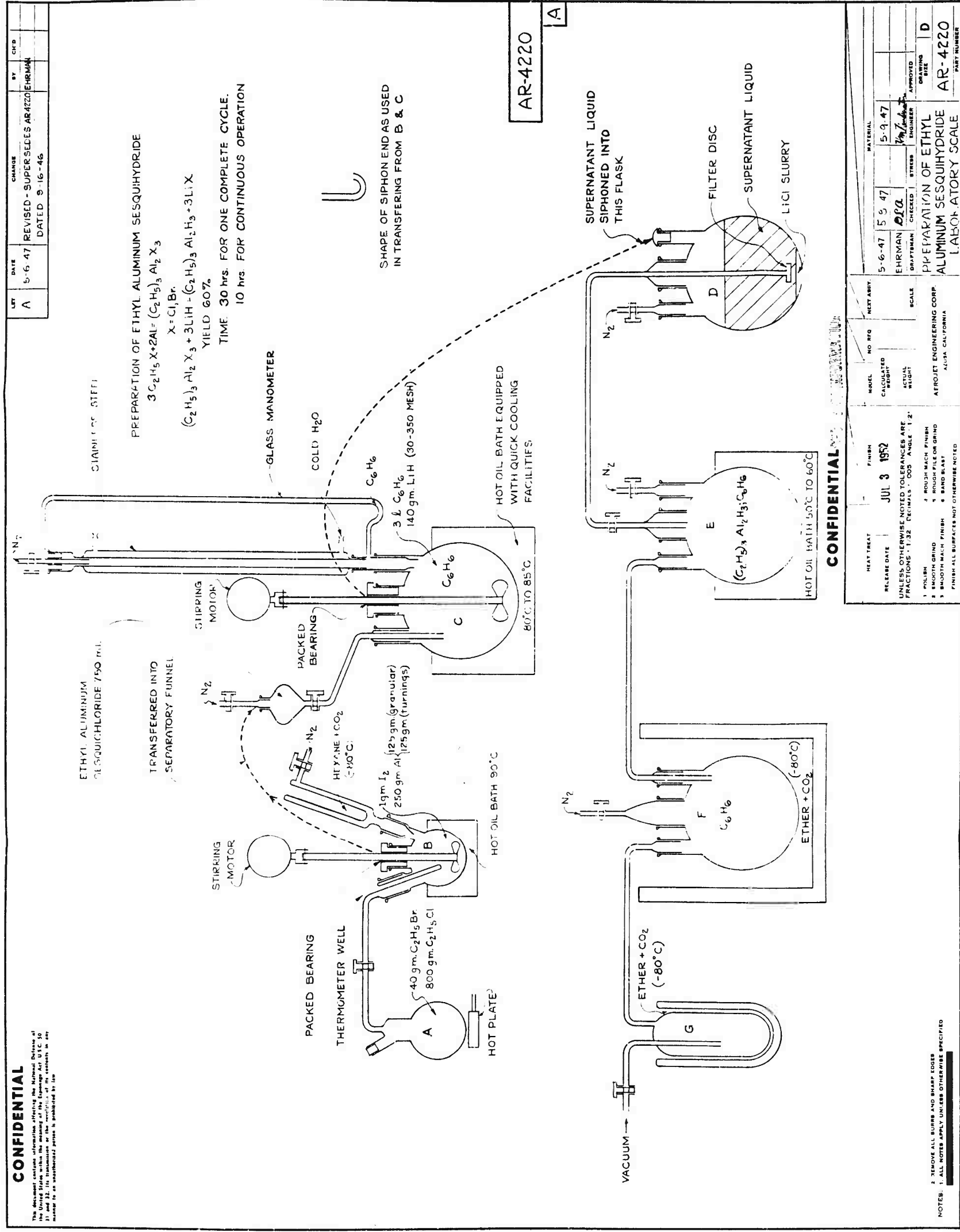
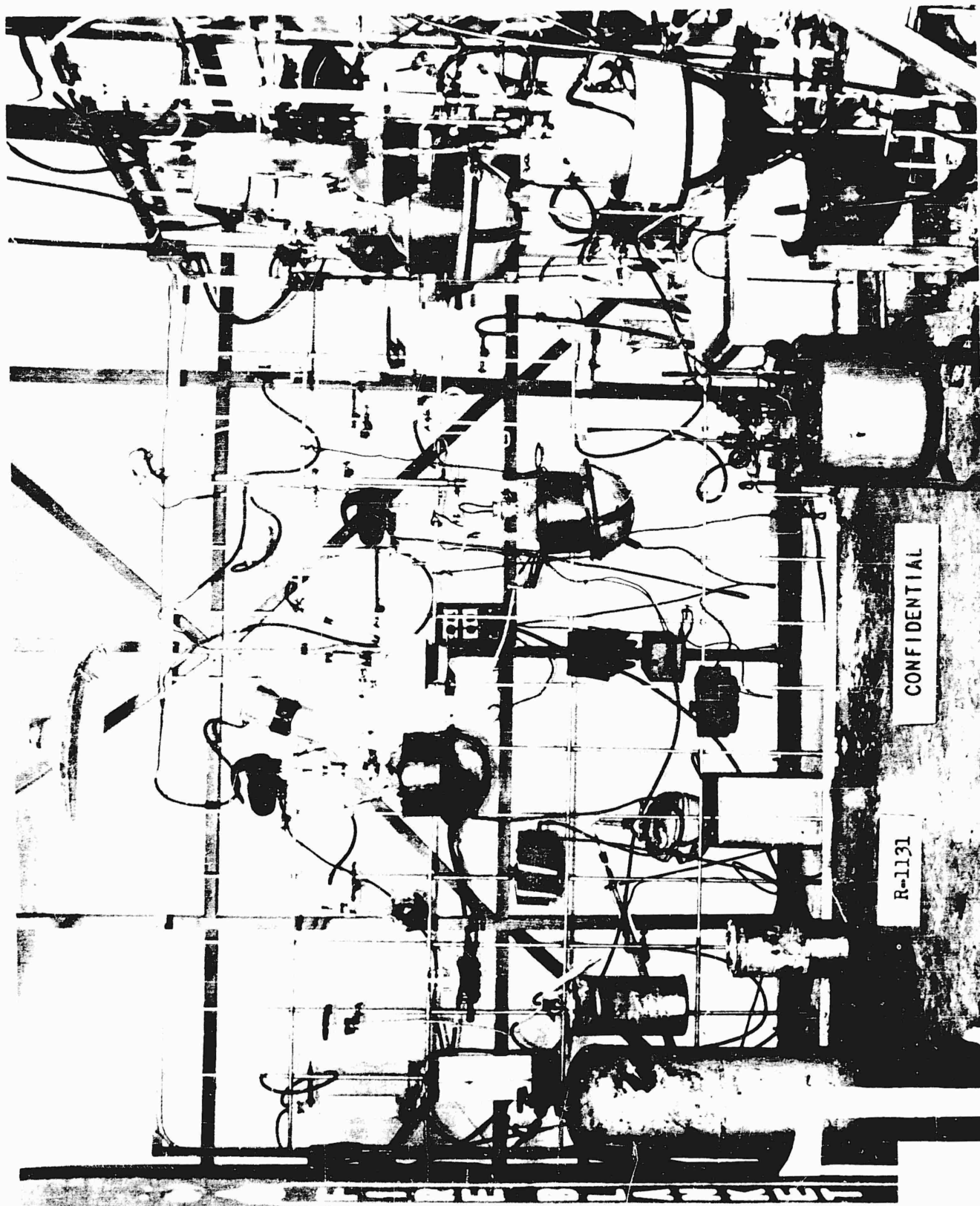


Figure 95

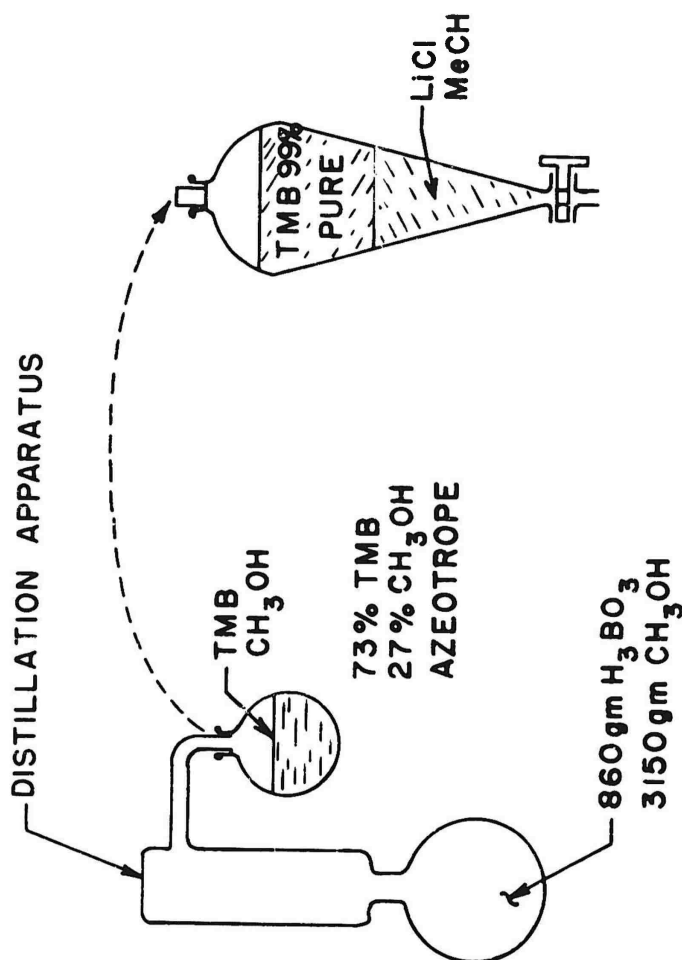
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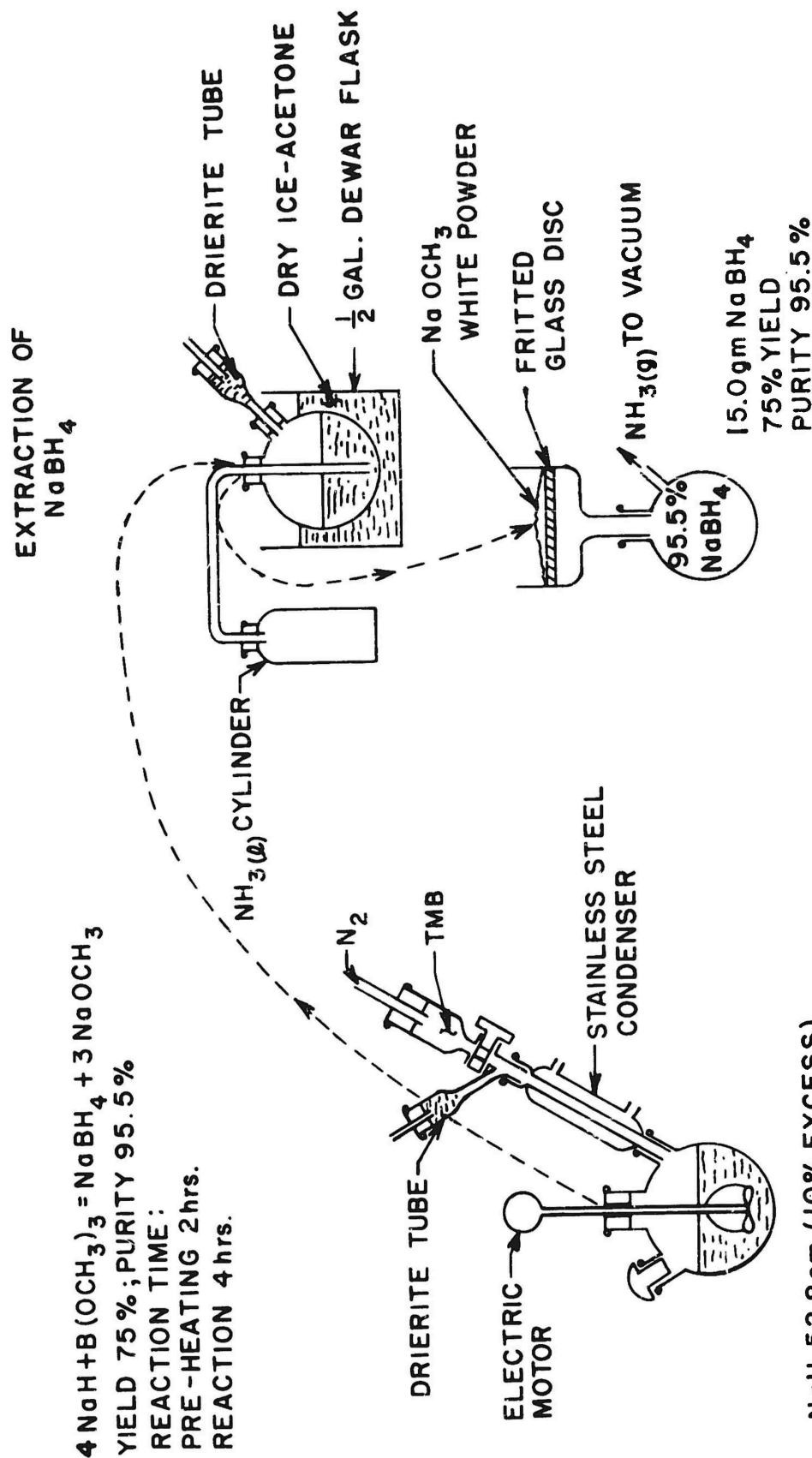
Ethyl Aluminum Sesquihydride Preparation Apparatus

NO. 682
5-27-47

$H_3BO_3 + 8 CH_3OH = (CH_3O)_3B + 3H_2O + 5CH_3OH$
YIELD 70% 1010 gm; PURITY 99%
16 hrs.



SYNTHESIS OF ALUMINUM BOROHYDRIDE
STEP I PREPARATION OF TRIMETHYL BORATE



SYNTHESIS OF ALUMINUM BOROHYDRIDE
STEP 2 - PREPARATION OF SODIUM BOROHYDRIDE

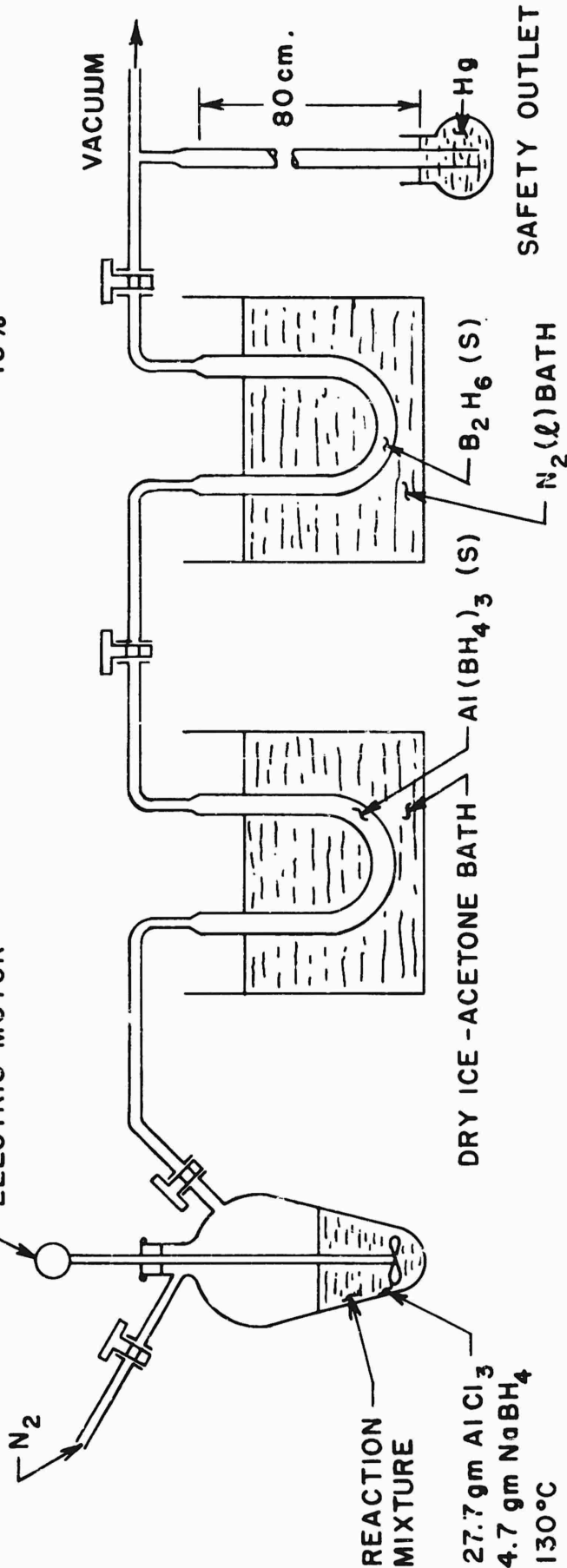
NO. 583
 5-27-47

Figure 98

2.5 gm; 85% YIELD; 2 hrs.
95% PURITY
OVER-ALL EFFICIENCY
OF 3 STEP PROCESS;
45%



ELECTRIC MOTOR



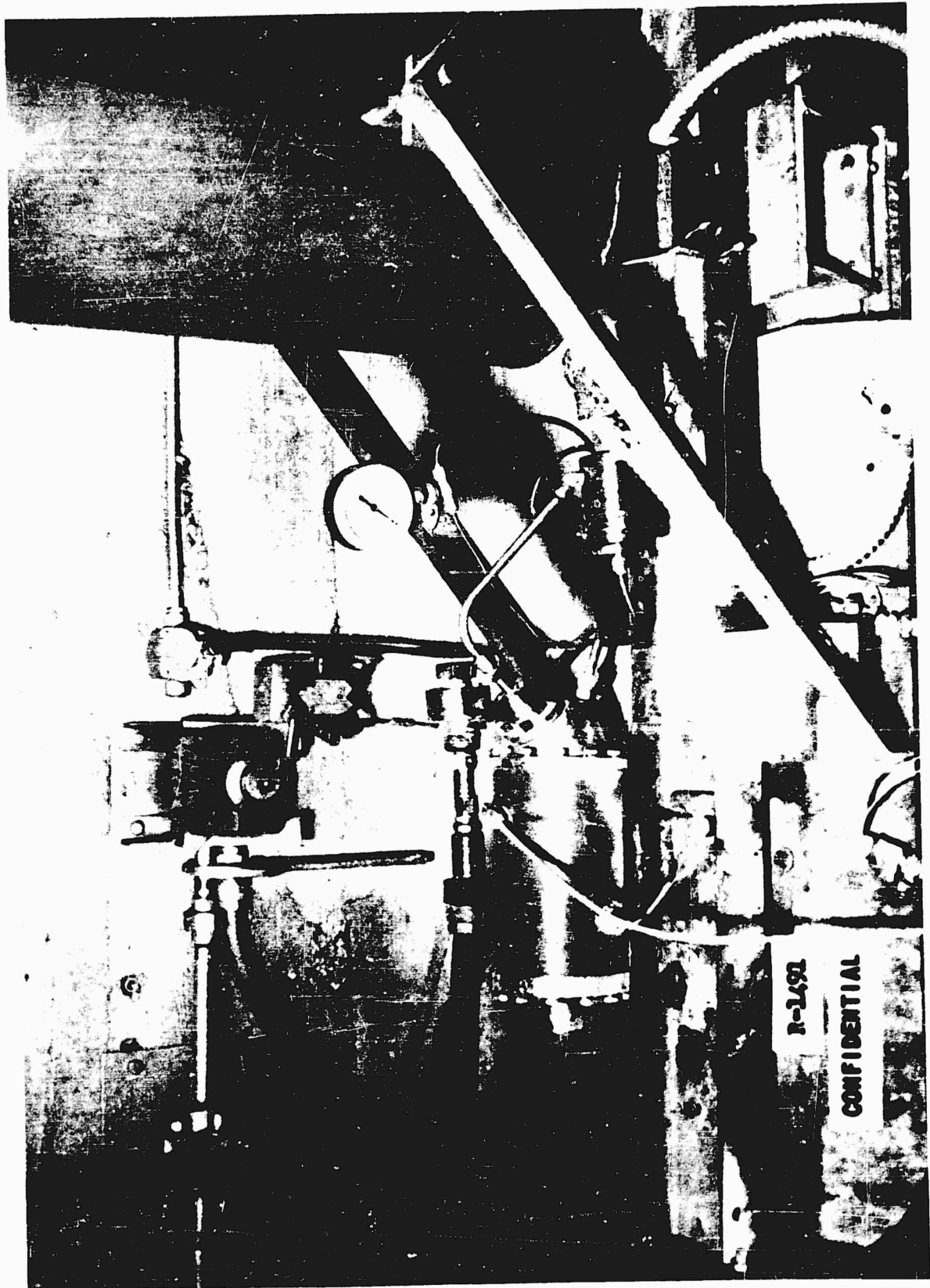
SYNTHESIS OF ALUMINUM BOROHYDRIDE

STEP 3 - PREPARATION OF $\text{Al}(\text{BH}_4)_3$

NO. 684
5-28-47

CONFIDENTIAL

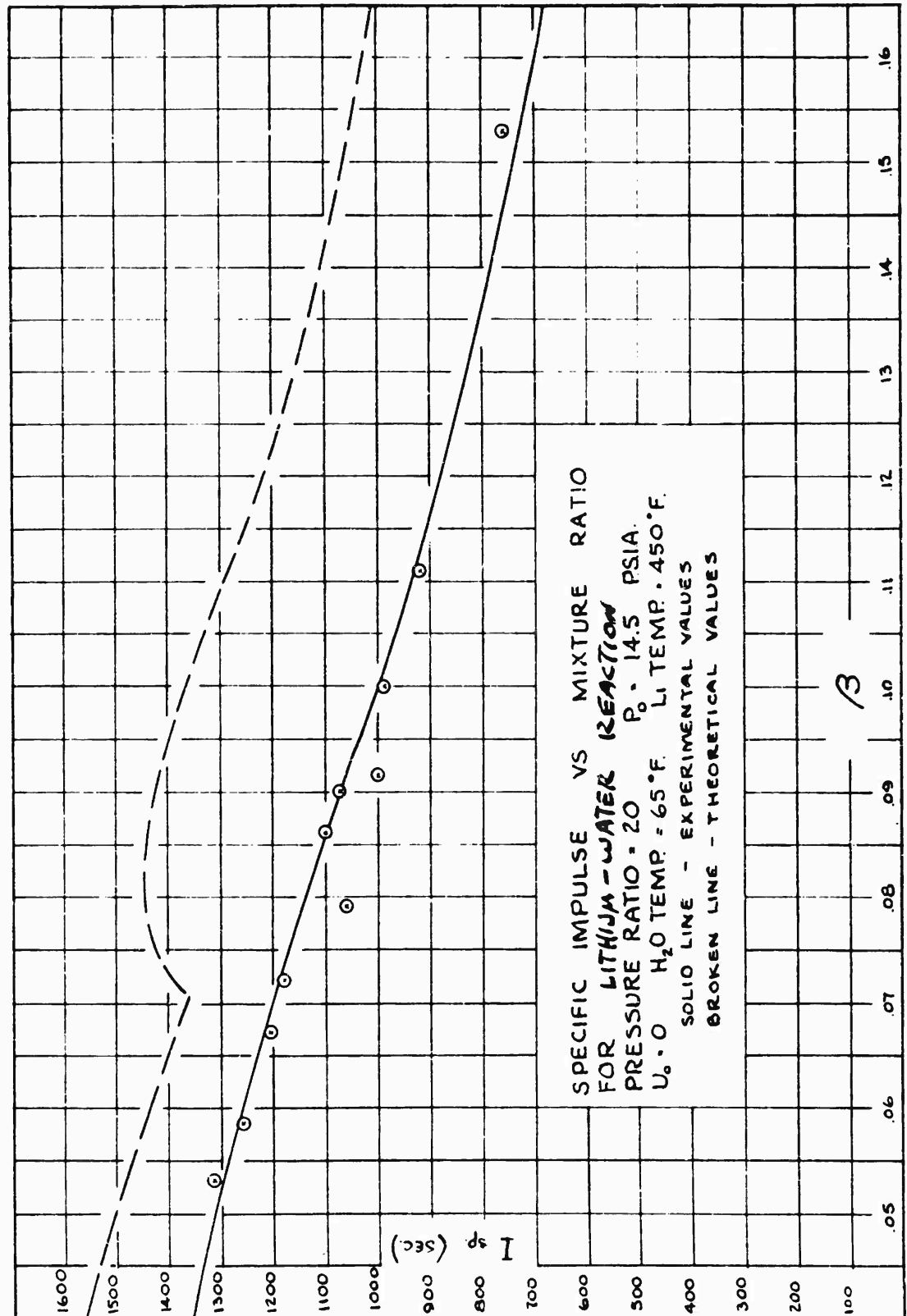
Report No. 1106



Molten-Lithium and Water Rocket Motor Installation

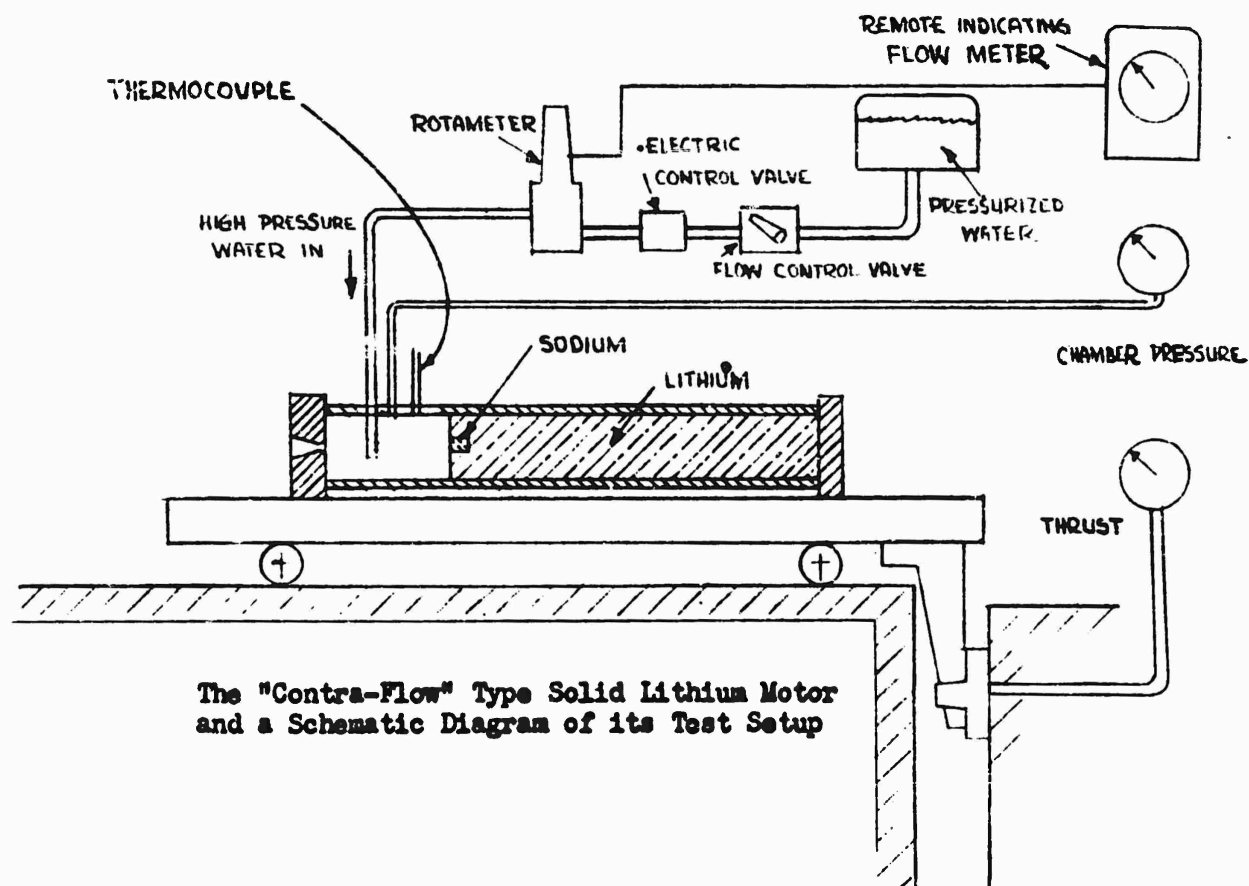
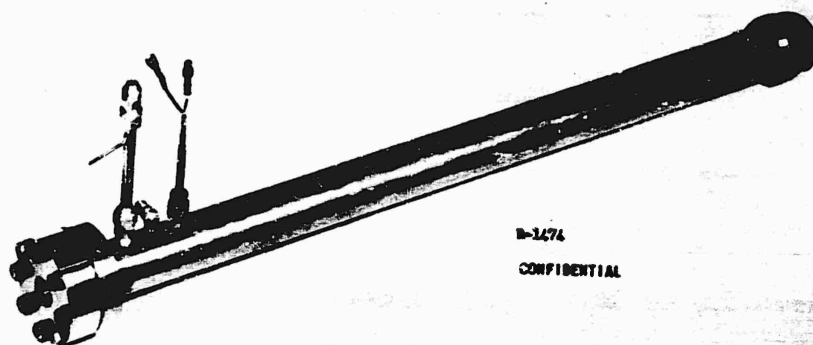
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Figure 100



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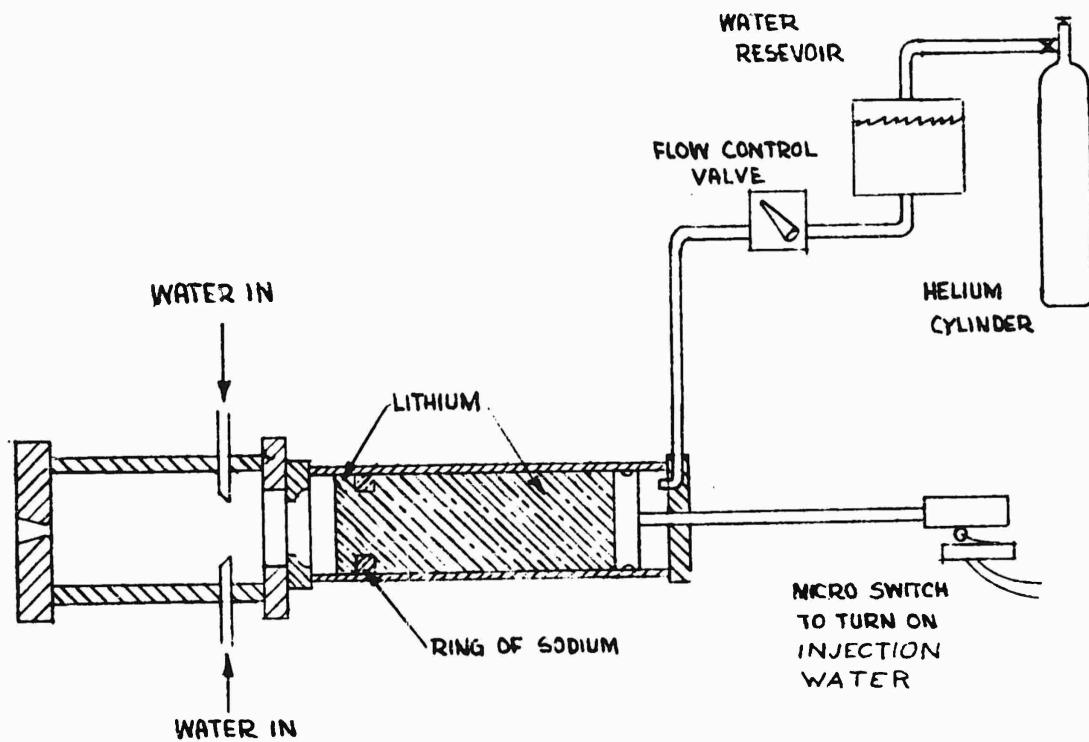
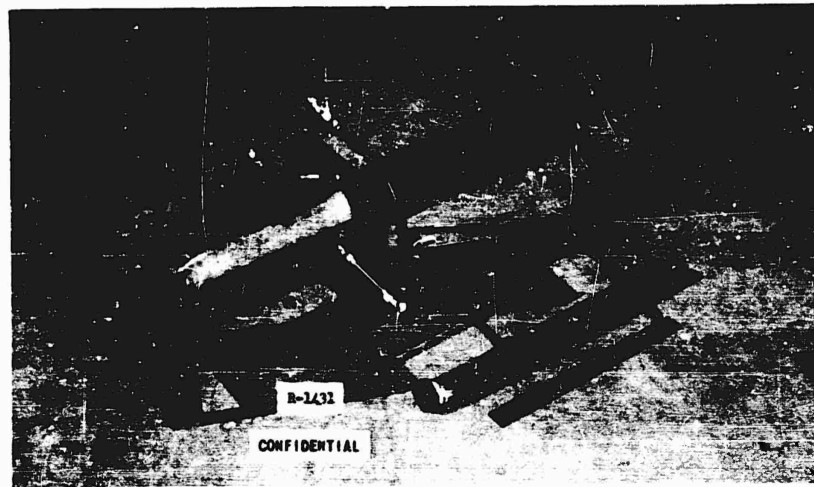
Report No. 1106



The "Contra-Flow" Type Solid Lithium Motor and a Schematic Diagram of its Test Setup

CONFIDENTIAL

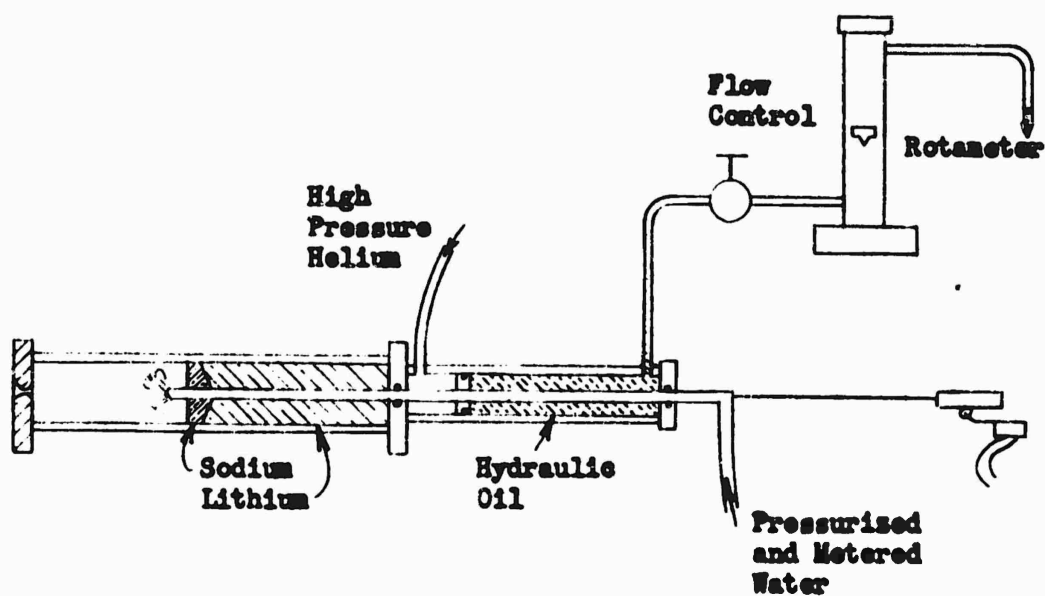
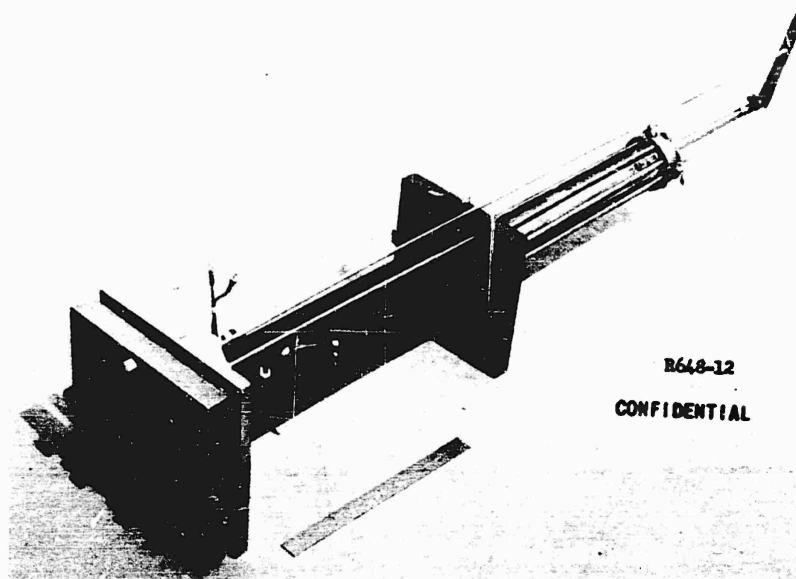
Figure 102



An "Extrusion" Solid Lithium Meter
and a Schematic Diagram of its Test Setup

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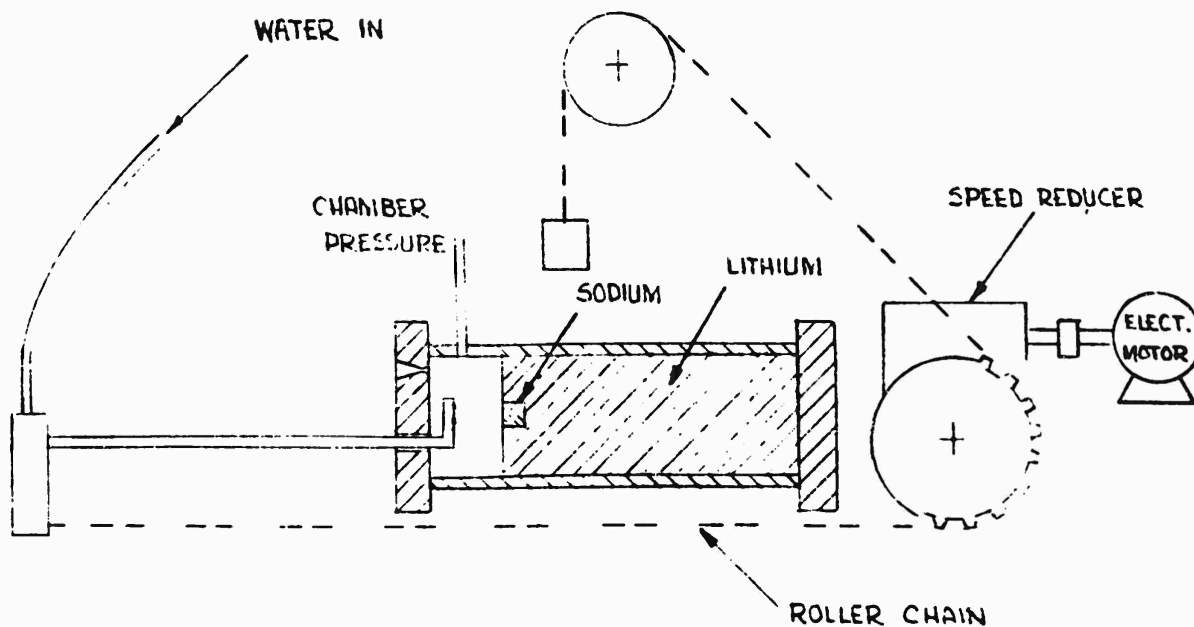
Report No. 1106



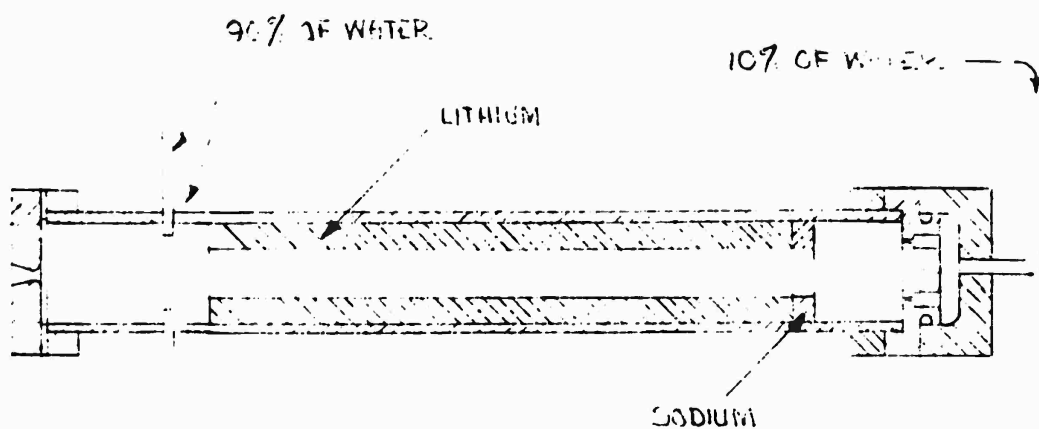
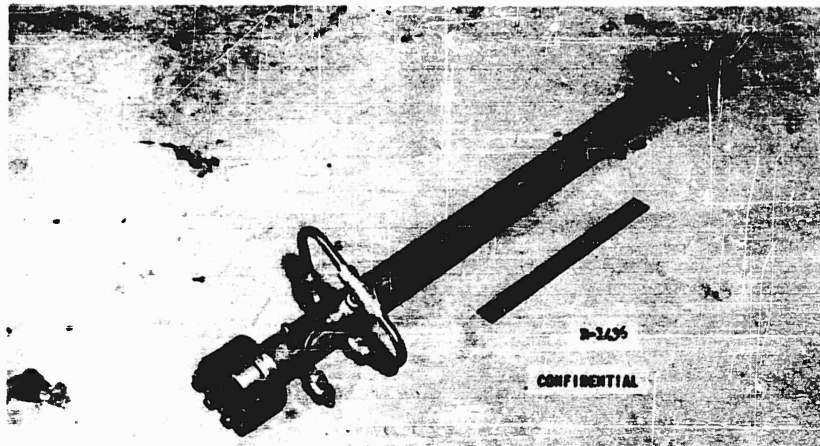
The "Traveling Injector" Solid Lithium Motor
and a Schematic Diagram of its Test Setup

CONFIDENTIAL

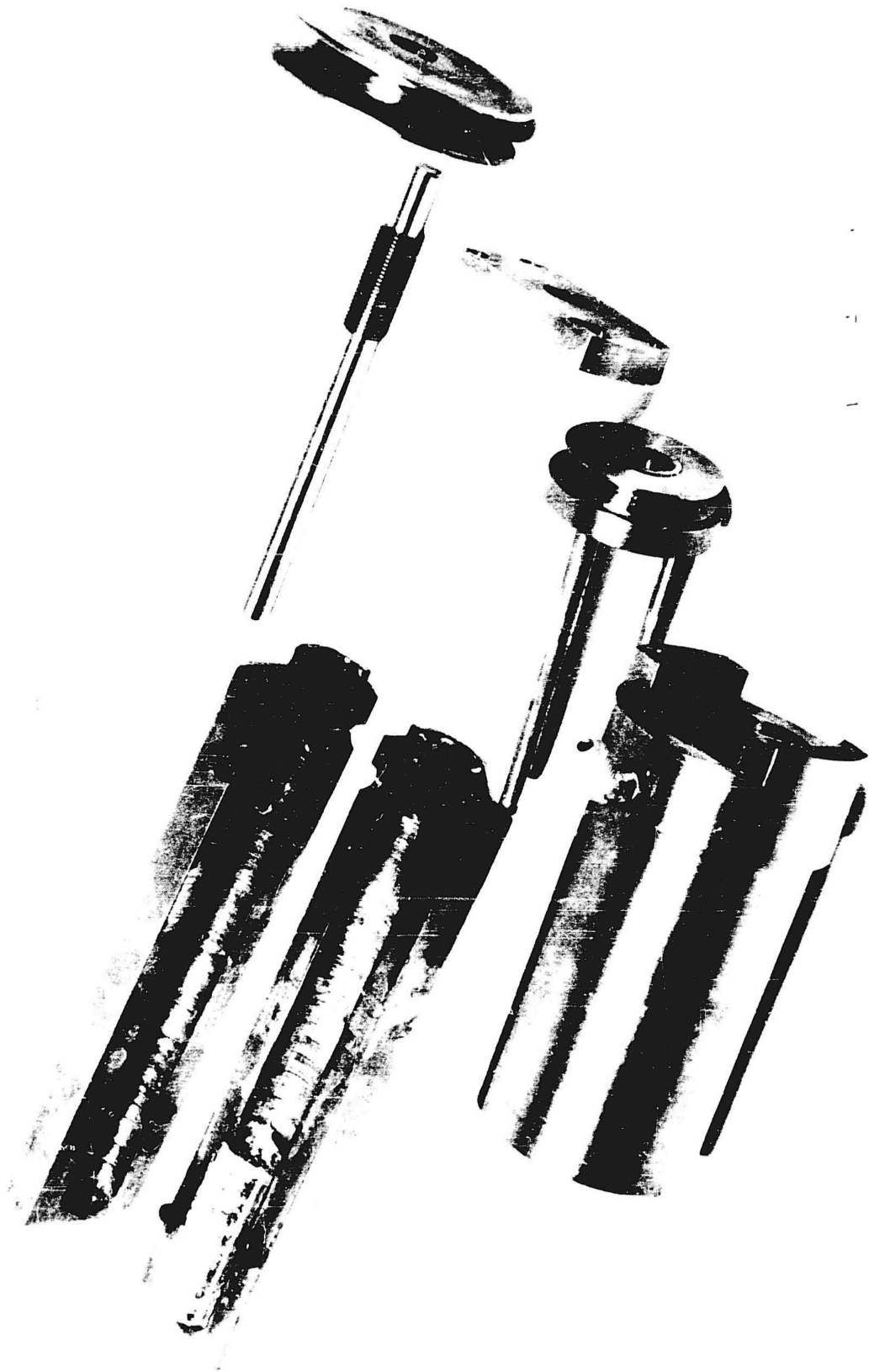
Figure 104



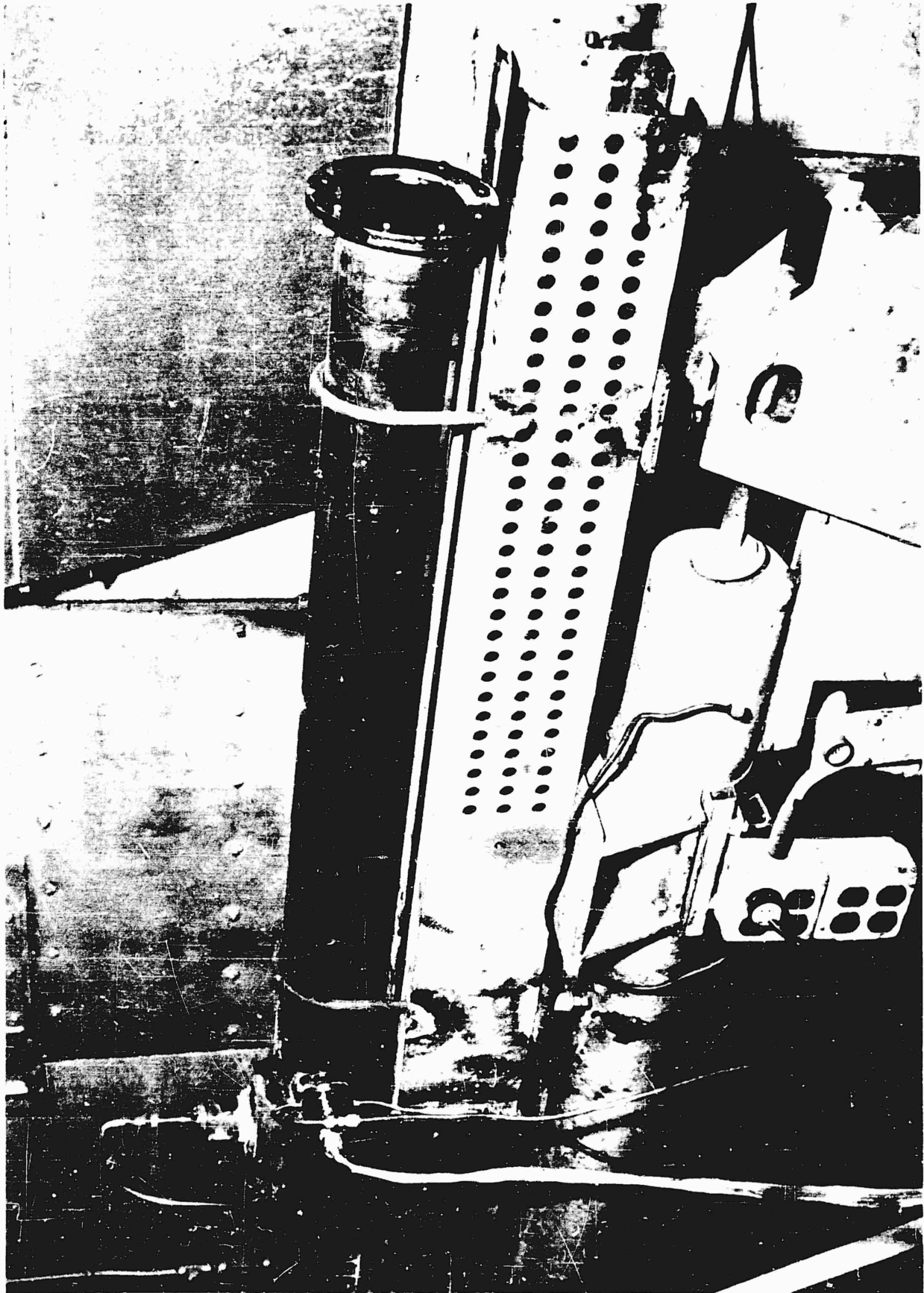
A "Traveling-Injector" Second Type Solid-Lithium Motor, and a Schematic Diagram of its Test Setup



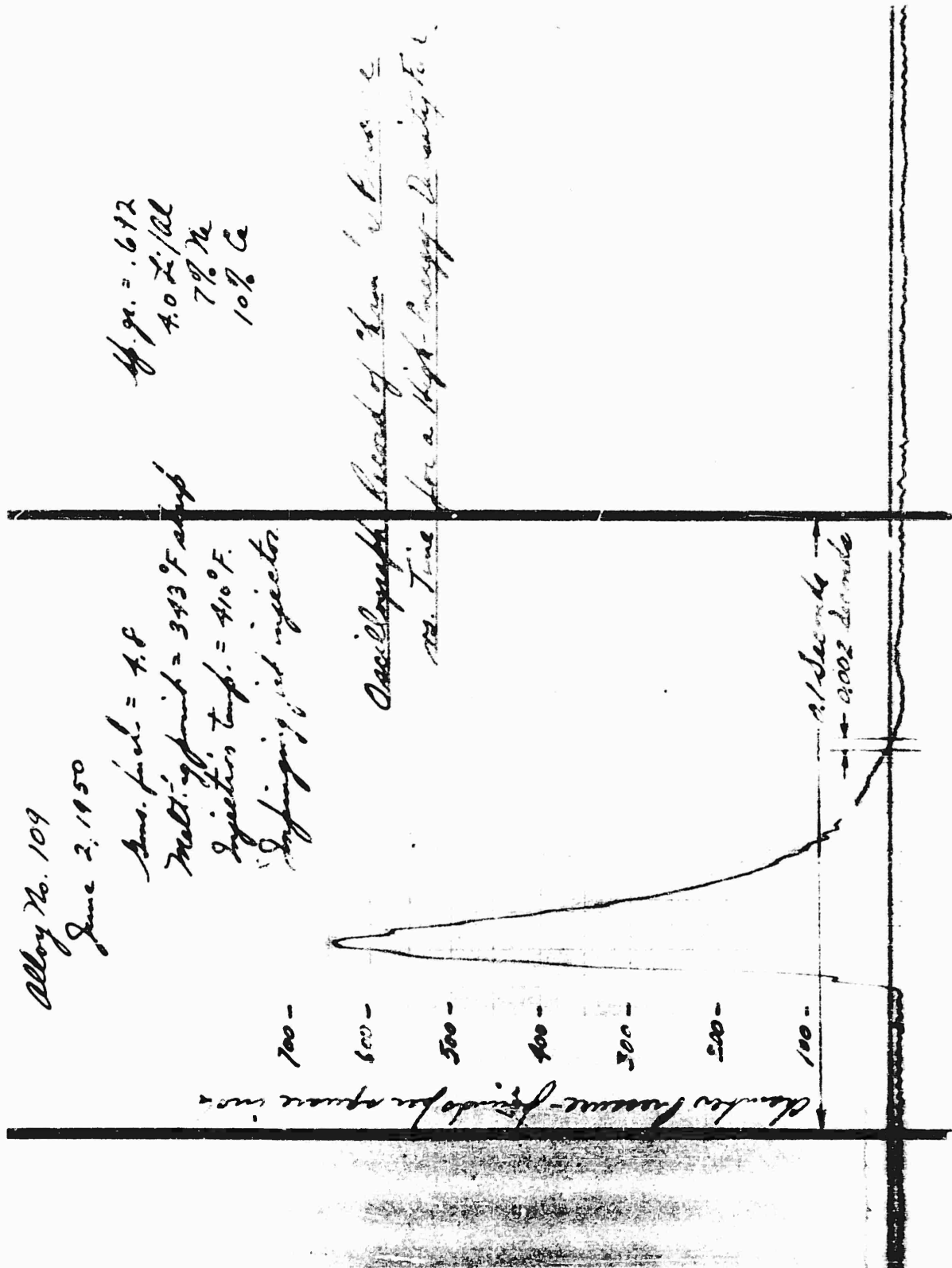
A "Direct Flow" Solid Lithium Motor
and a Schematic Diagram of Its Test Setup



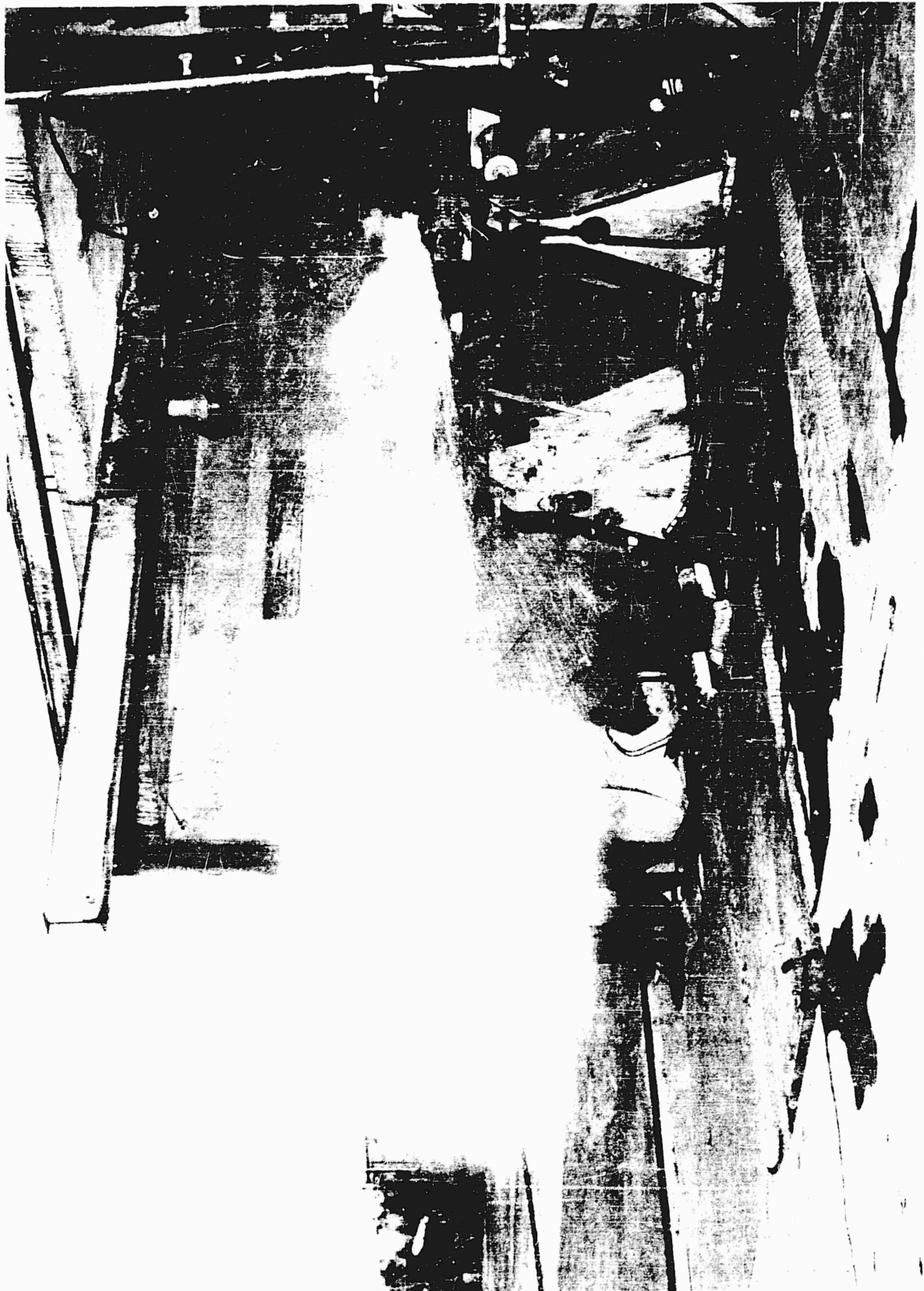
Alloy Melter Components



Single-Shot Direct Hydropulse Test Unit

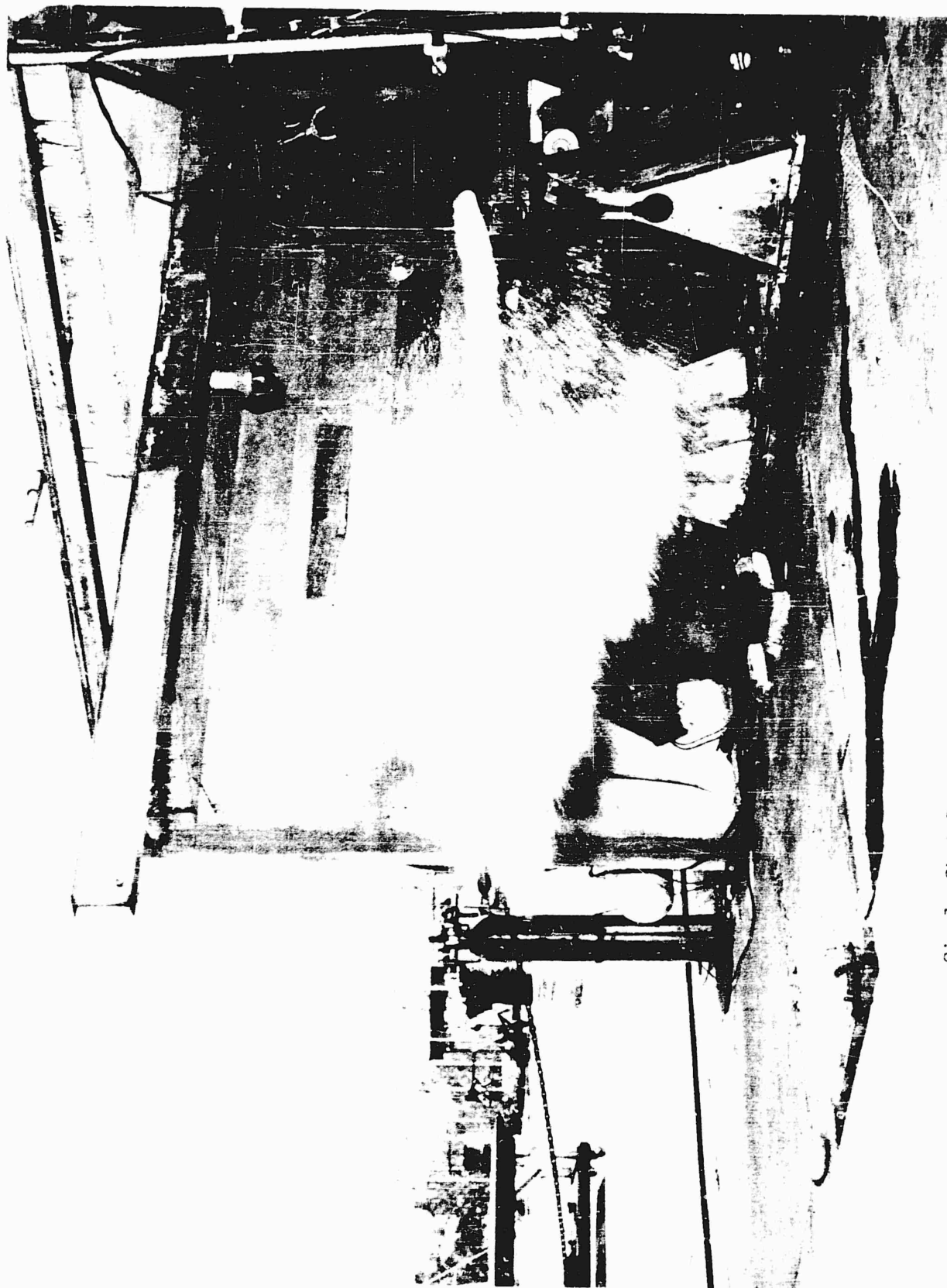


Pressure-Time Trace for a High-Energy-Density Fuel



Single-Shot, Direct Hydropulse, Lithium Fired

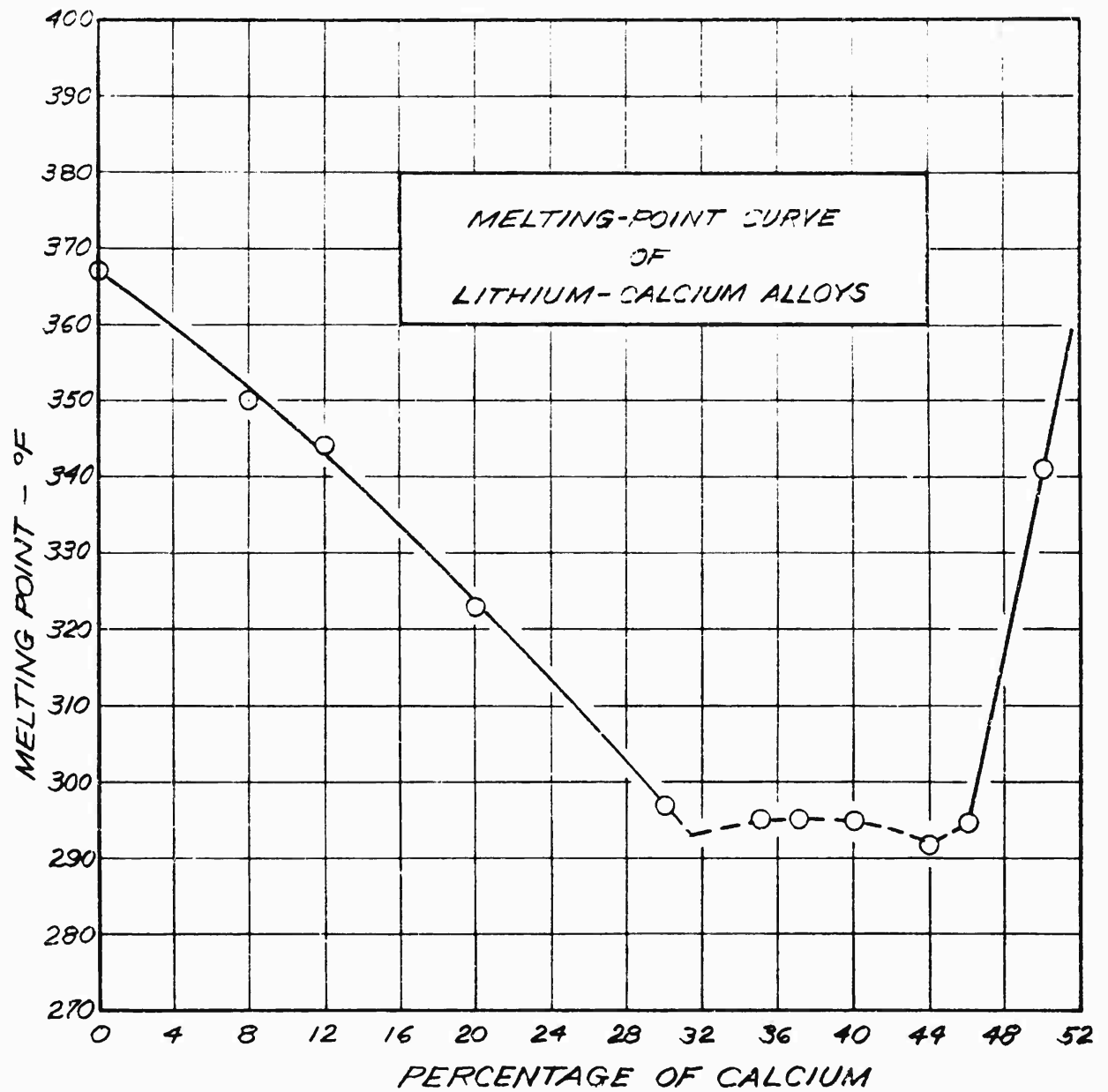
NO 110-11



Single-Shot Direct Hydropulse, Magnesium-Lithium Fired

CONFIDENTIAL

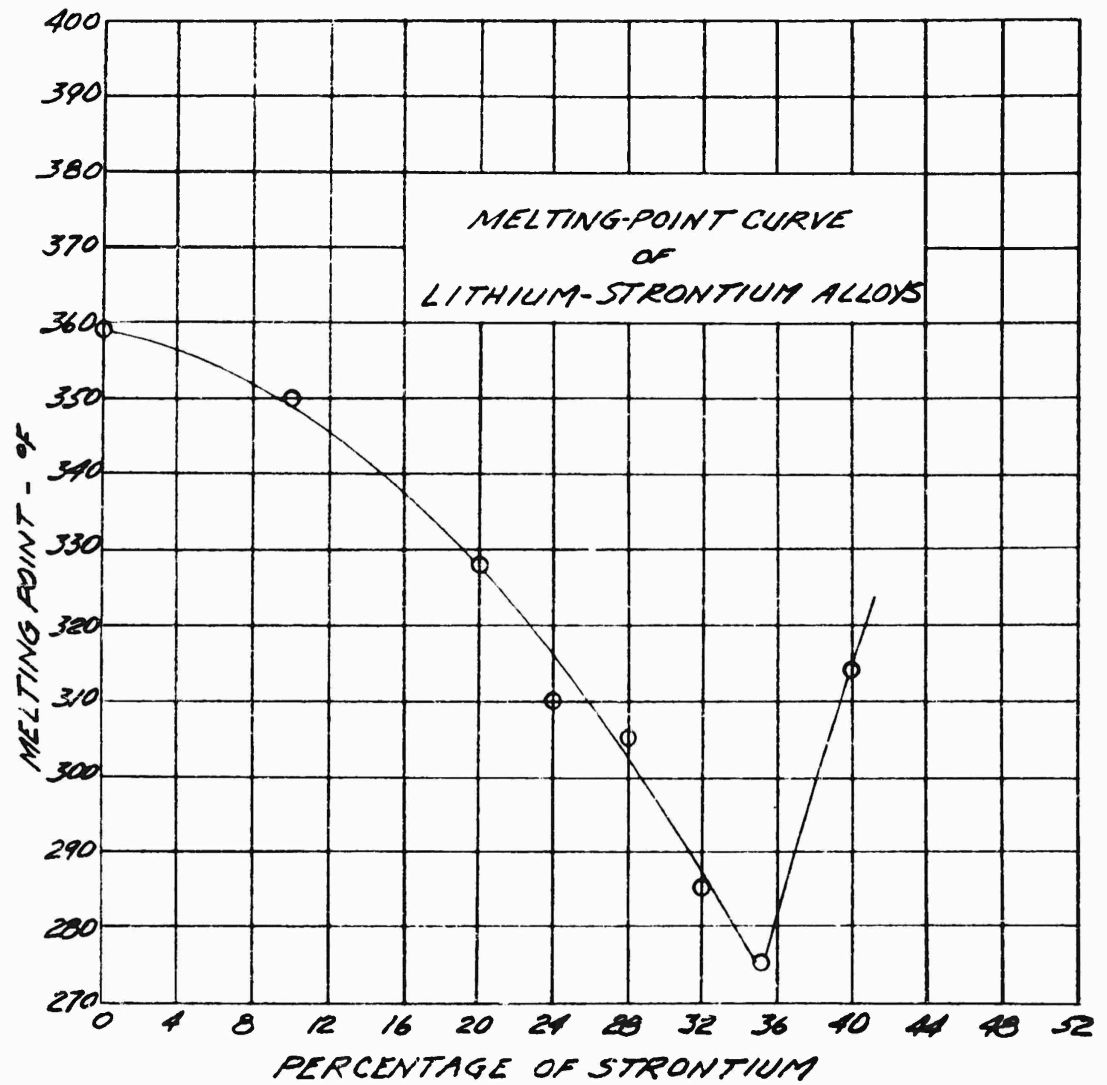
Report No. 1106



CURVE NO 4054 6-25-50 HIGGINS

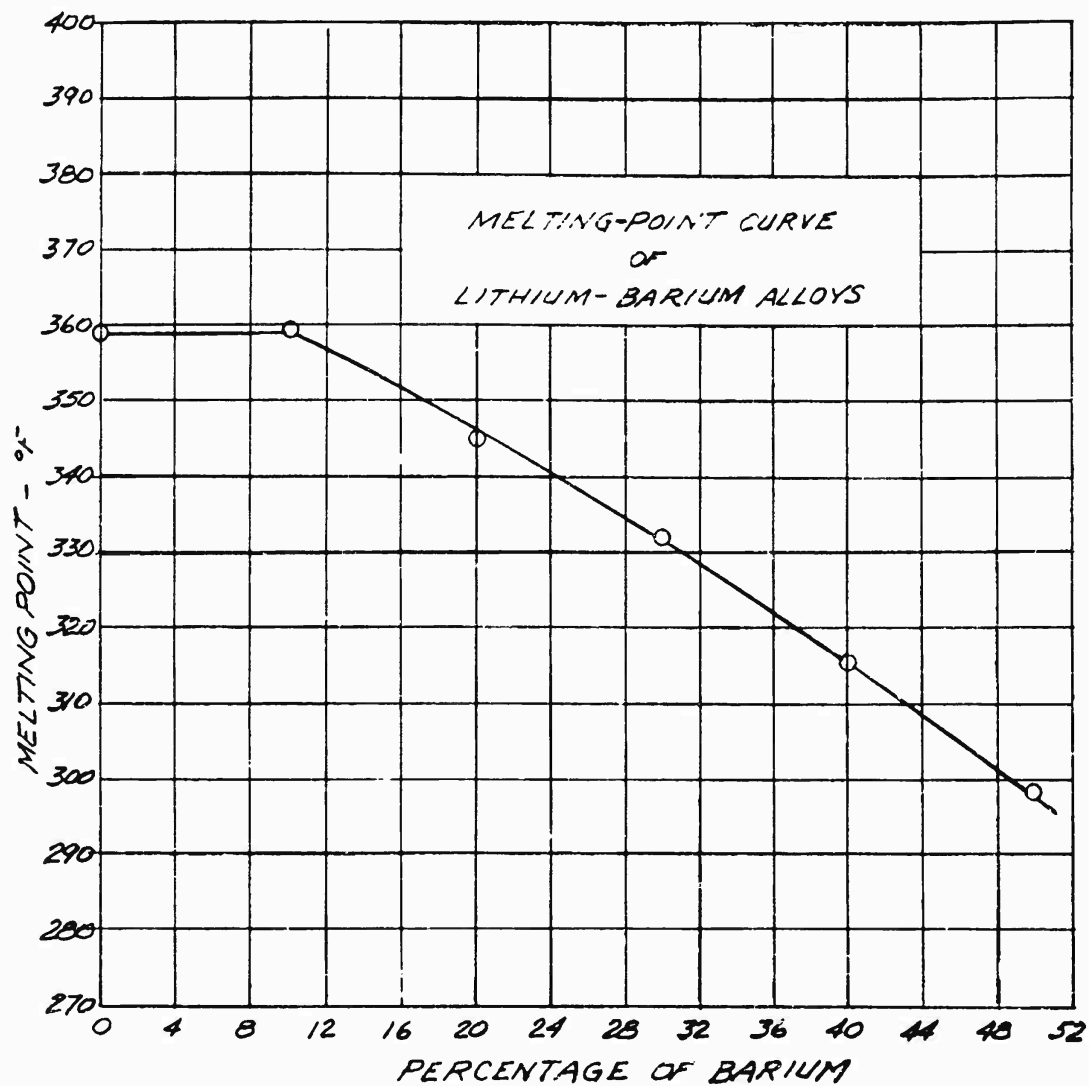
Figure 112

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CURVE NO. 4078 12-1-50 COX

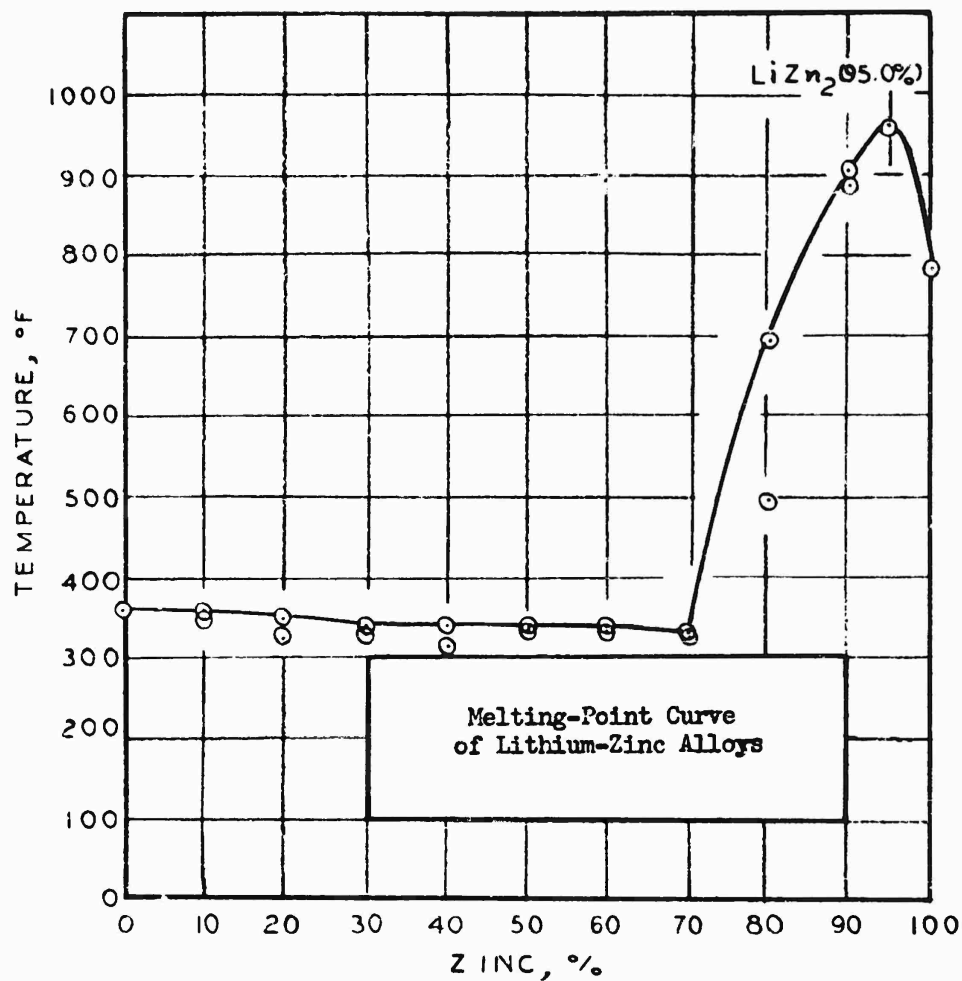
CURVE NO. 4064 12-1-50 COX



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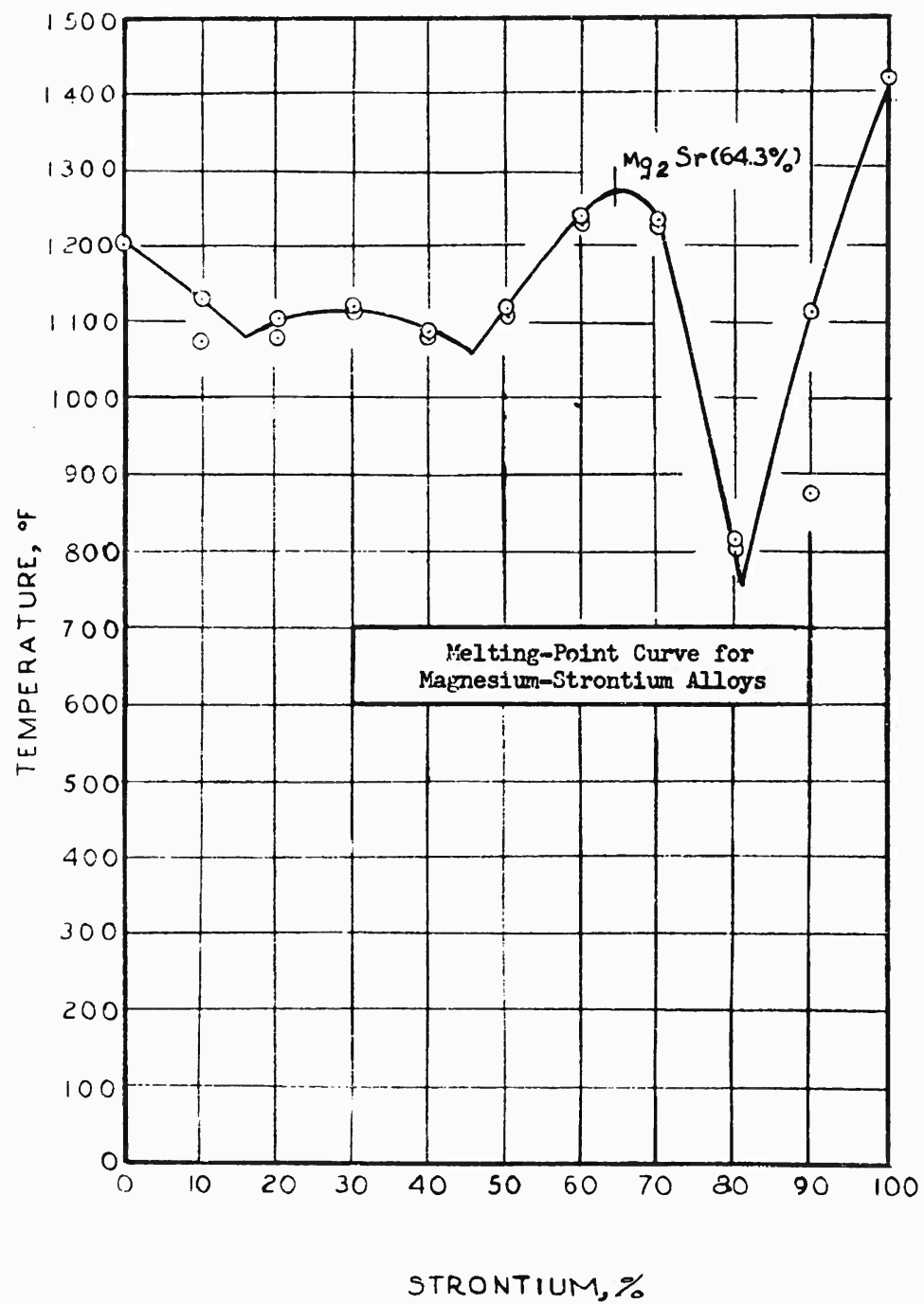
Report No. 1106

CURVE NO. 4094 6-26-51 R.B. COX/p.m.



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Figure 115

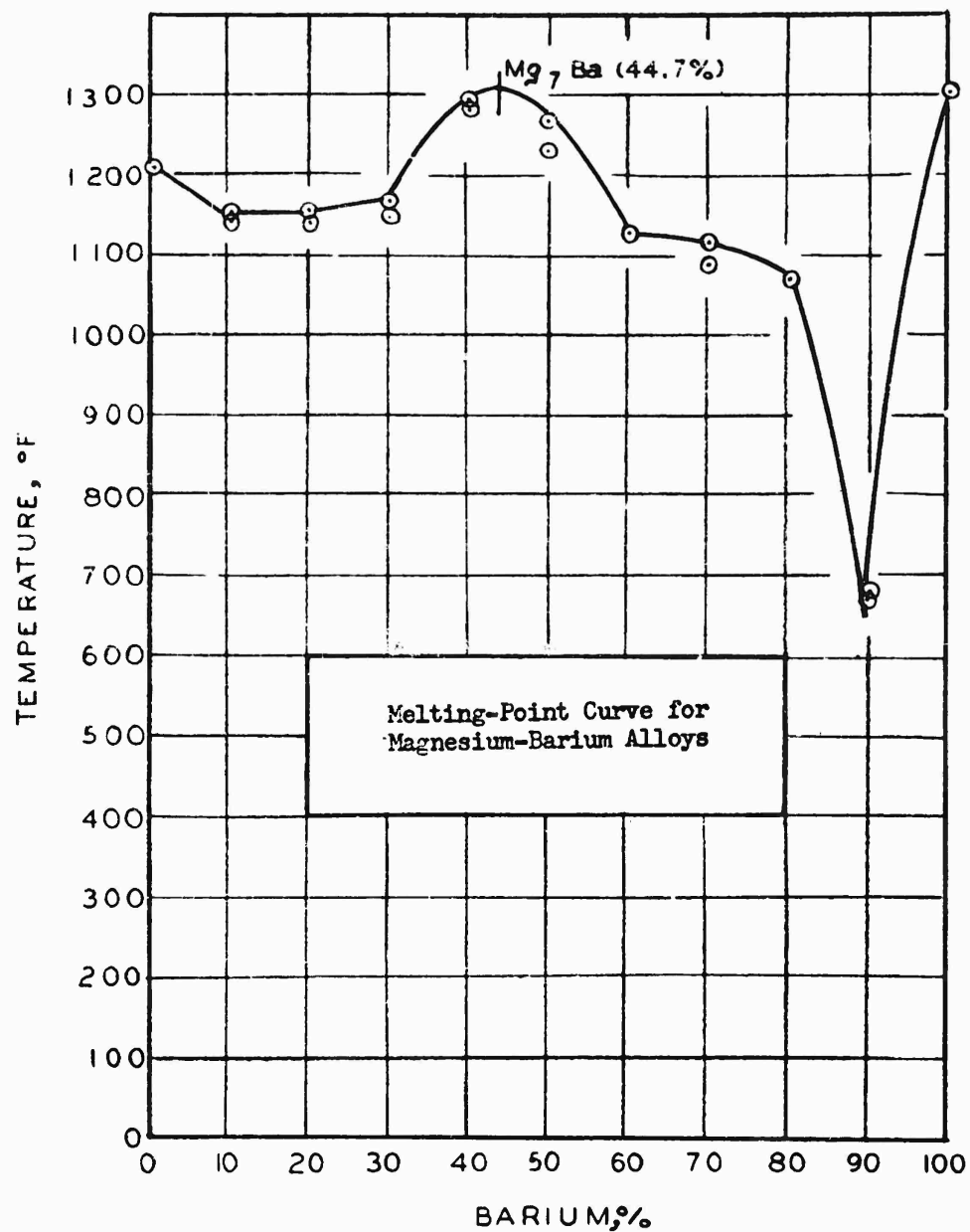


CURVE NO. 4095 6-26-51 R.B. COX/pn

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Report No. 1106

CURVE NO. 4096 6-26-51 R.B. COX



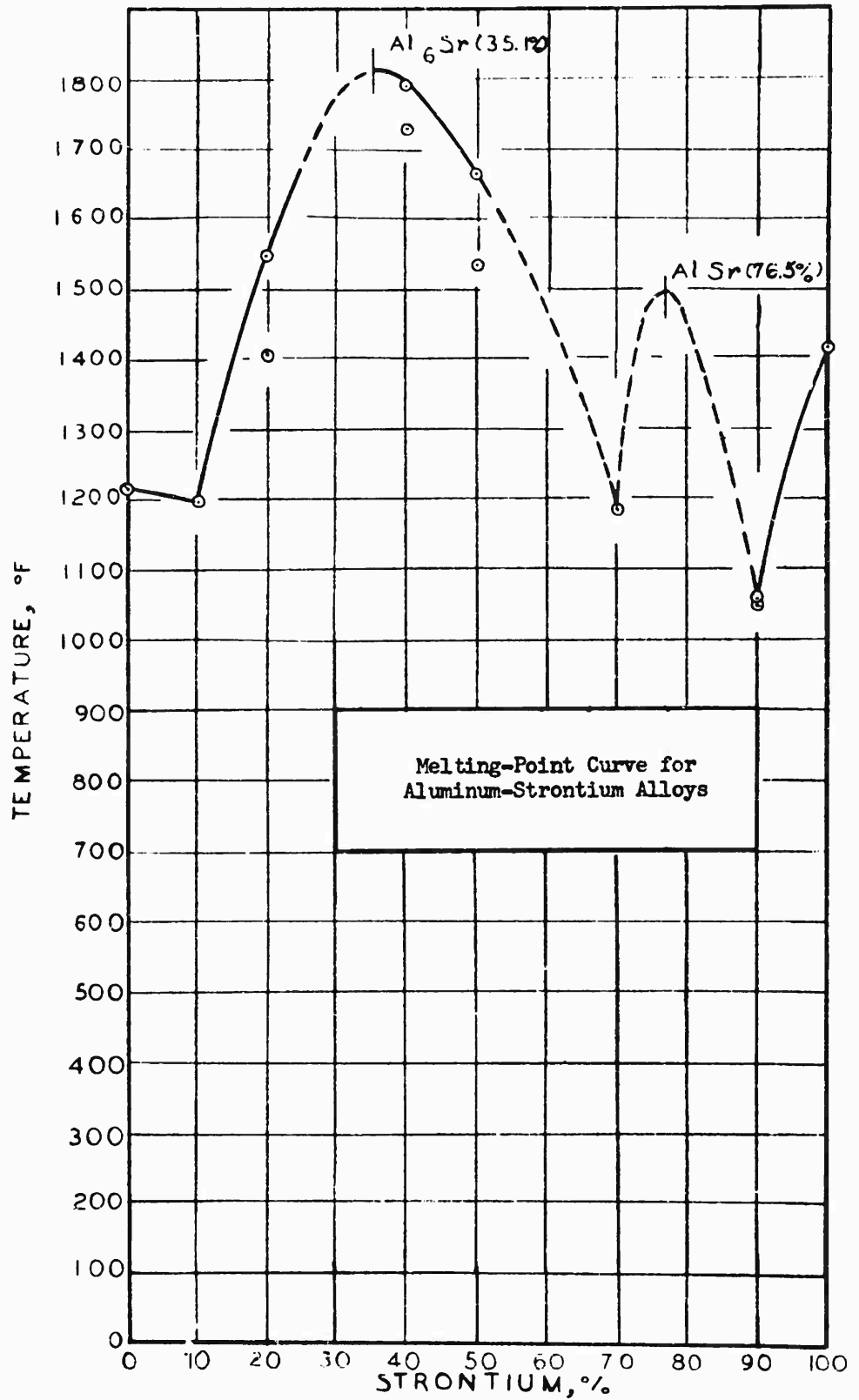
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Figure 117

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Report No. 1106

CURVE NO. 4092 6-26-51 R.B. COX/p.n.



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Figure 118

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Report No. 1106

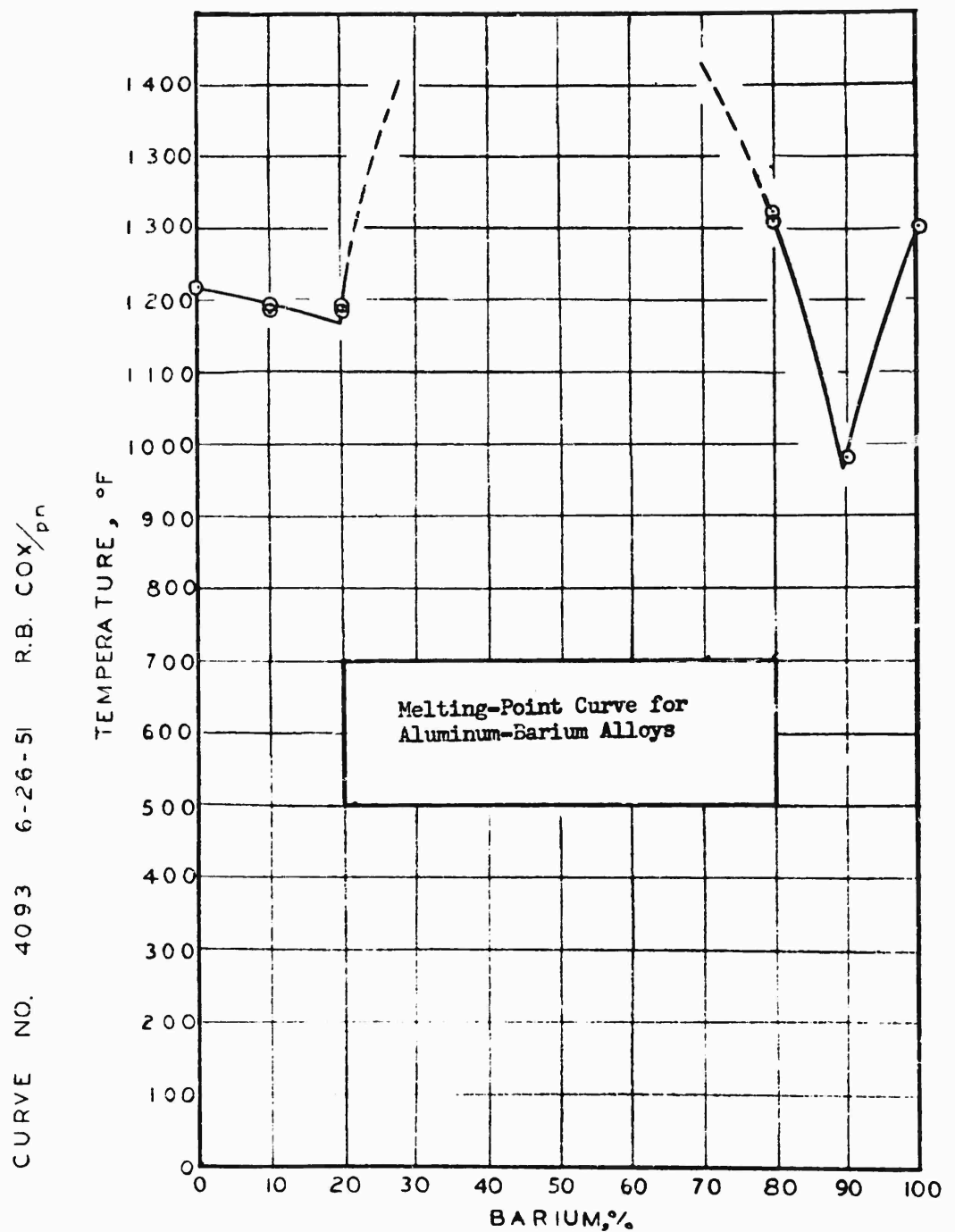
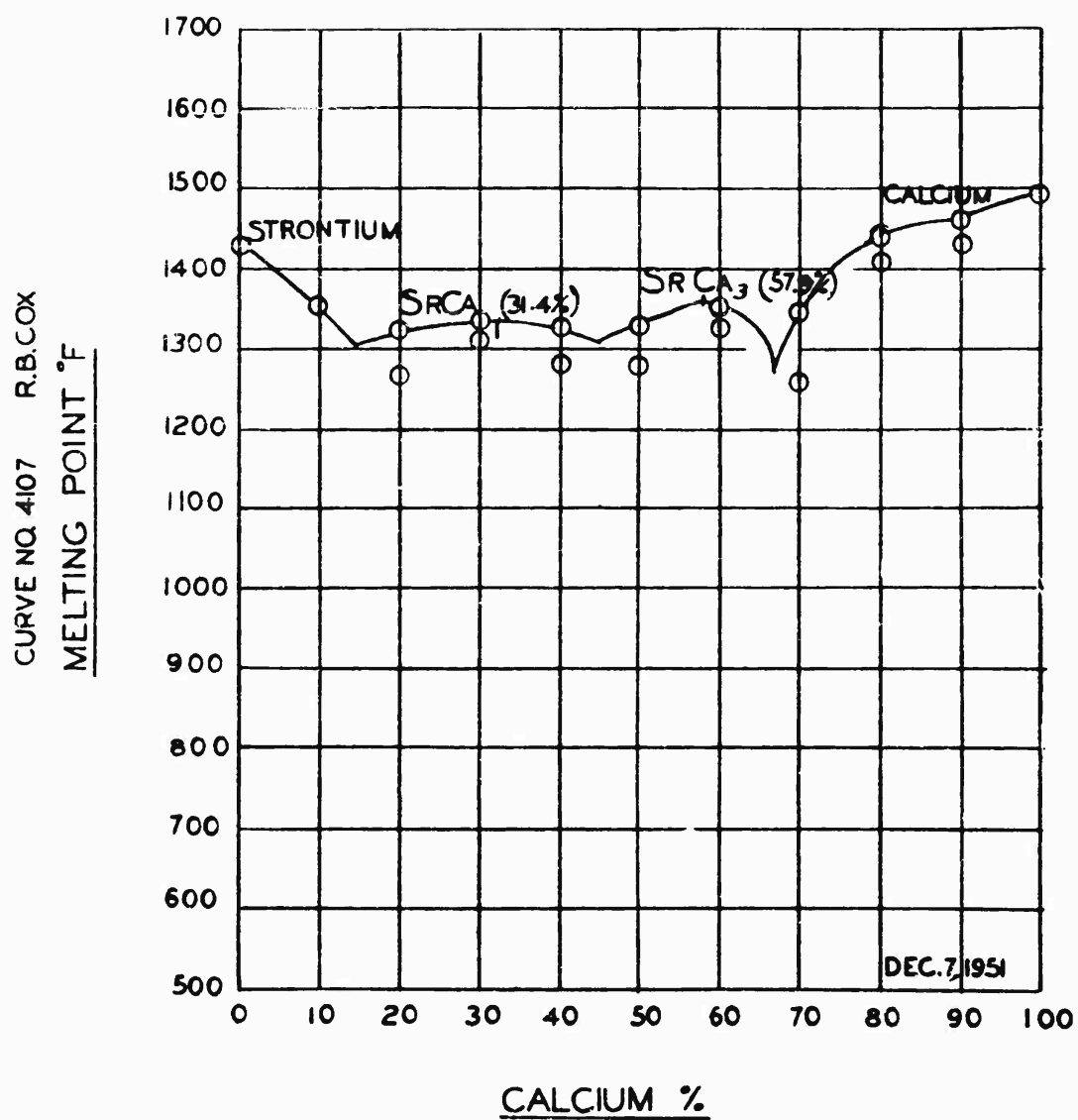


Figure 119

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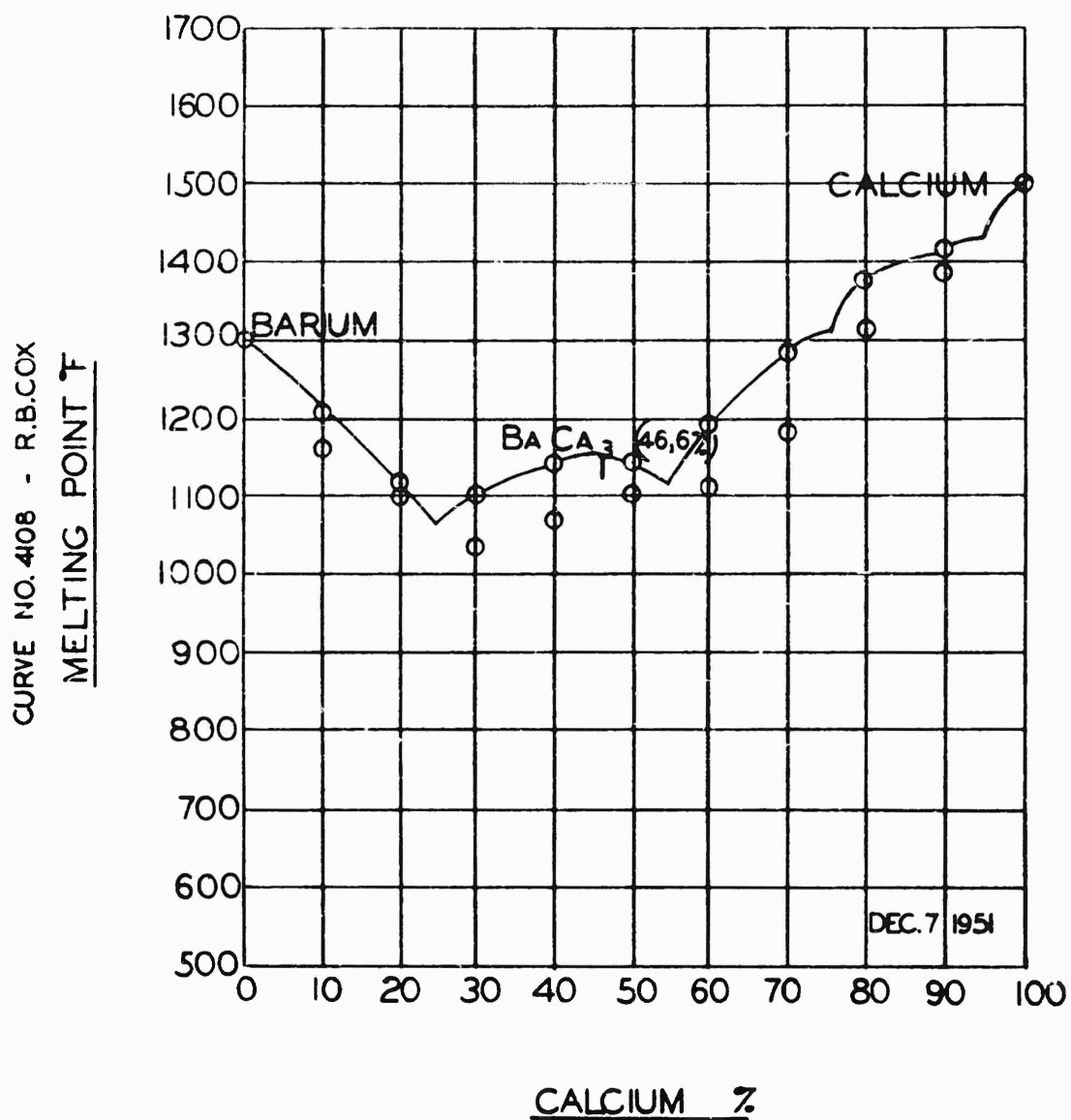
MELTING-POINT CURVE
OF
STRONTIUM-CALCIUM ALLOYS



CONFIDENTIAL

Report No. 1106

MELTING-POINT CURVE
OF
BARIUM-CALCIUM ALLOYS



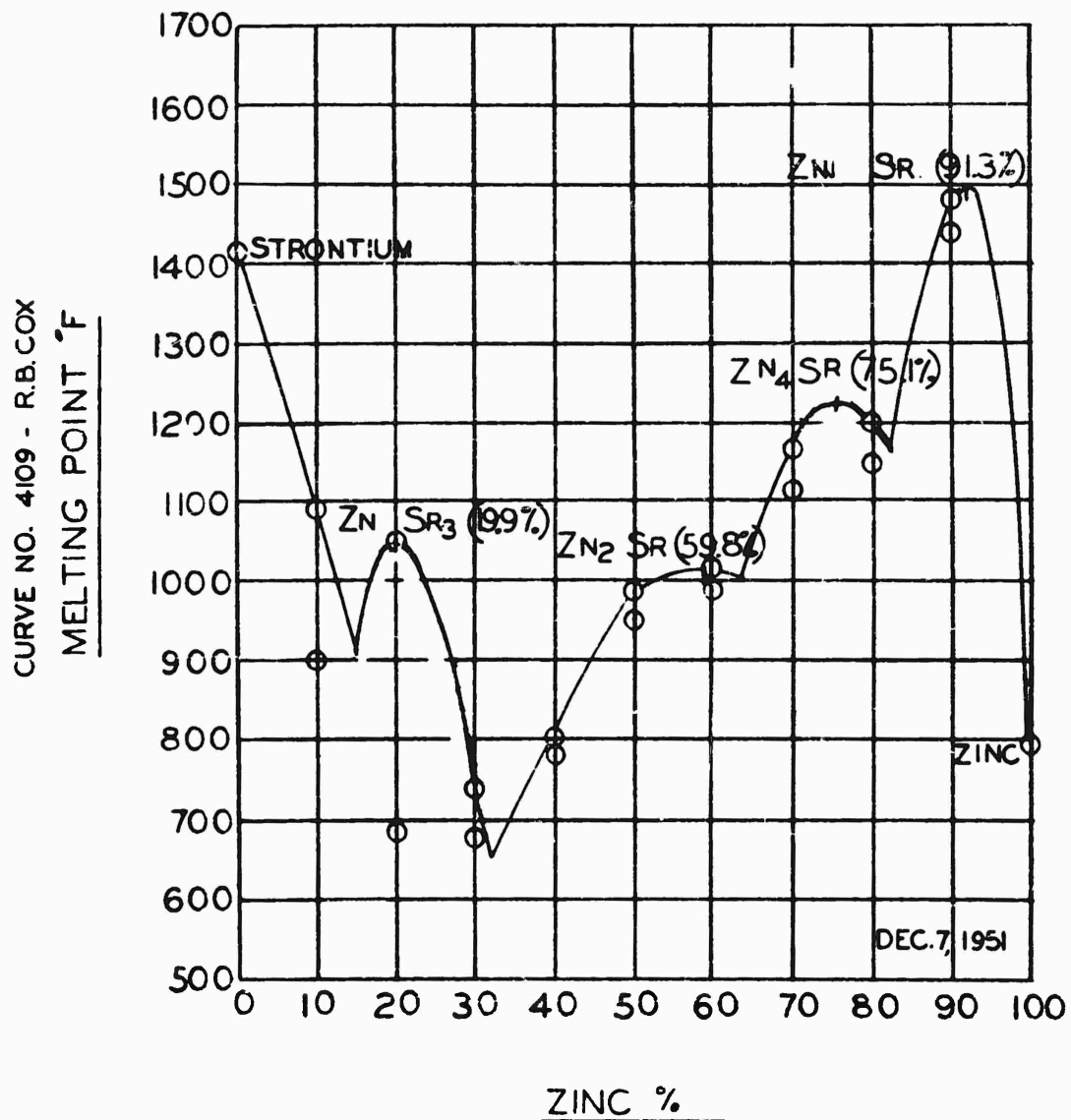
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Figure 121

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Report No. 1106

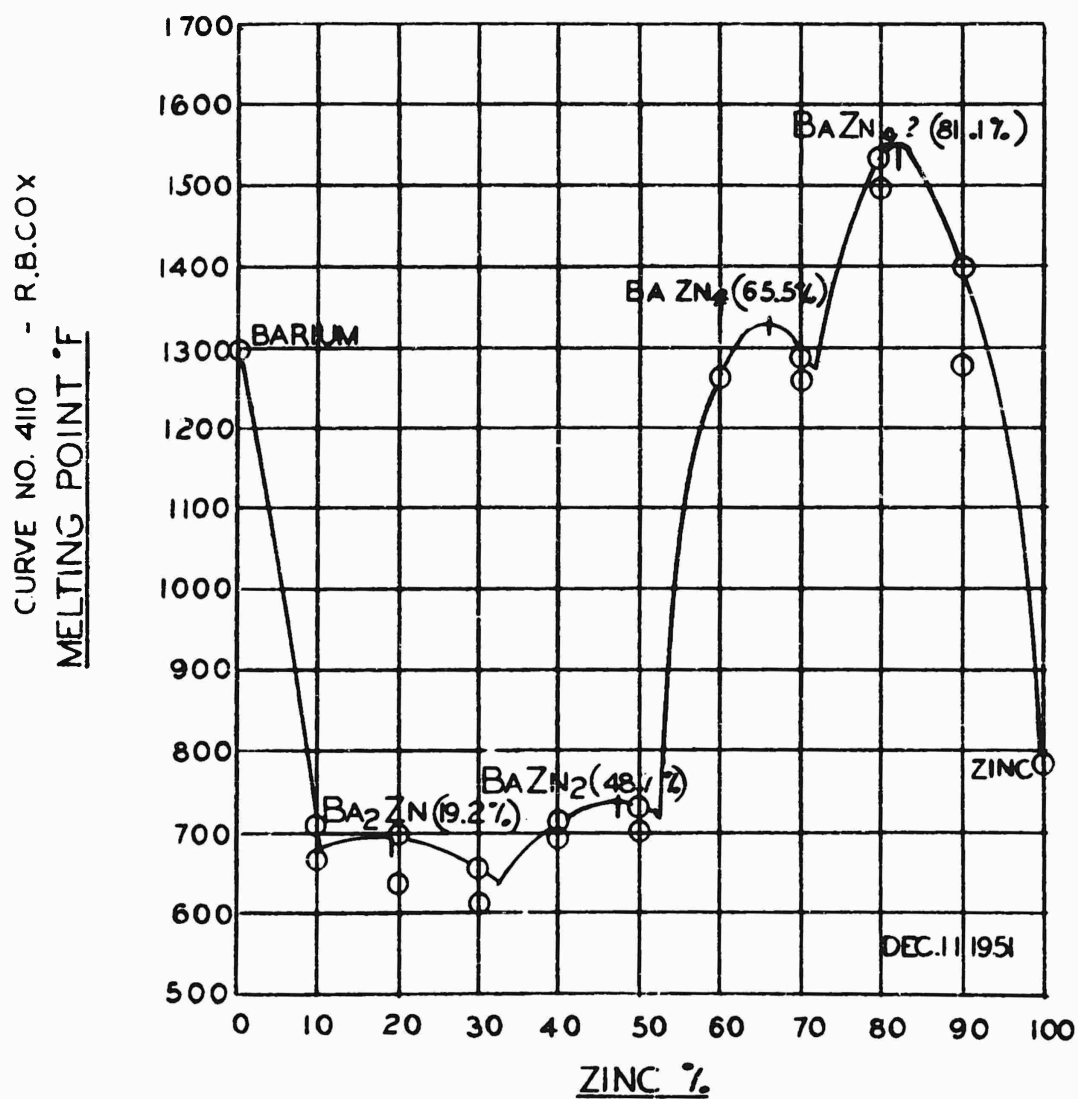
MELTING-POINT CURVE
OF
ZINC-STRONTIUM ALLOYS



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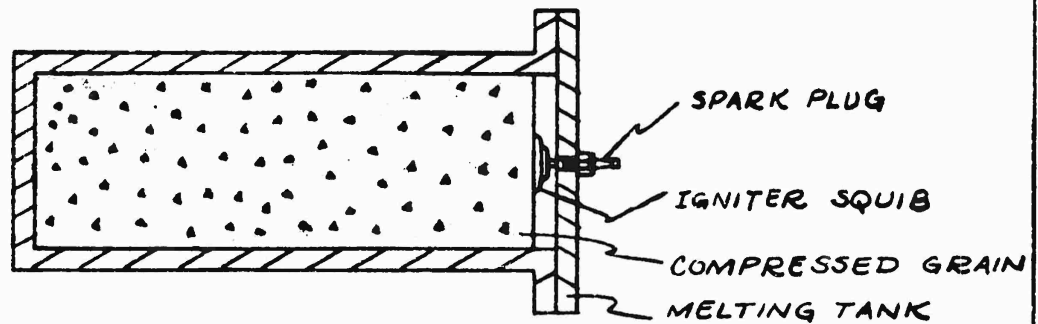
Figure 122

MELTING-POINT CURVE
OF
ZINC-BARIUM ALLOYS

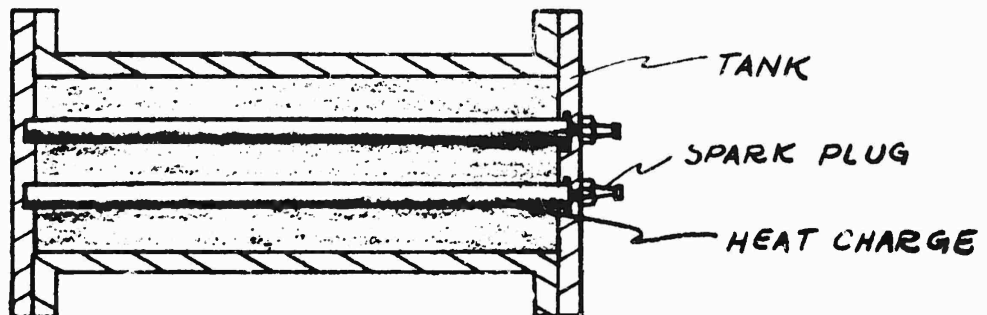


CURVE NO. 4111. 1-10-52 BMW

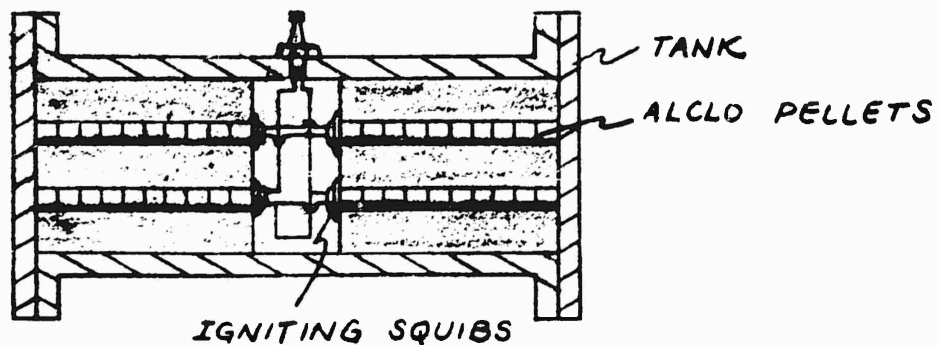
LITHIUM MELTING SYSTEMS



OXIDIZER-POWDERED LITHIUM

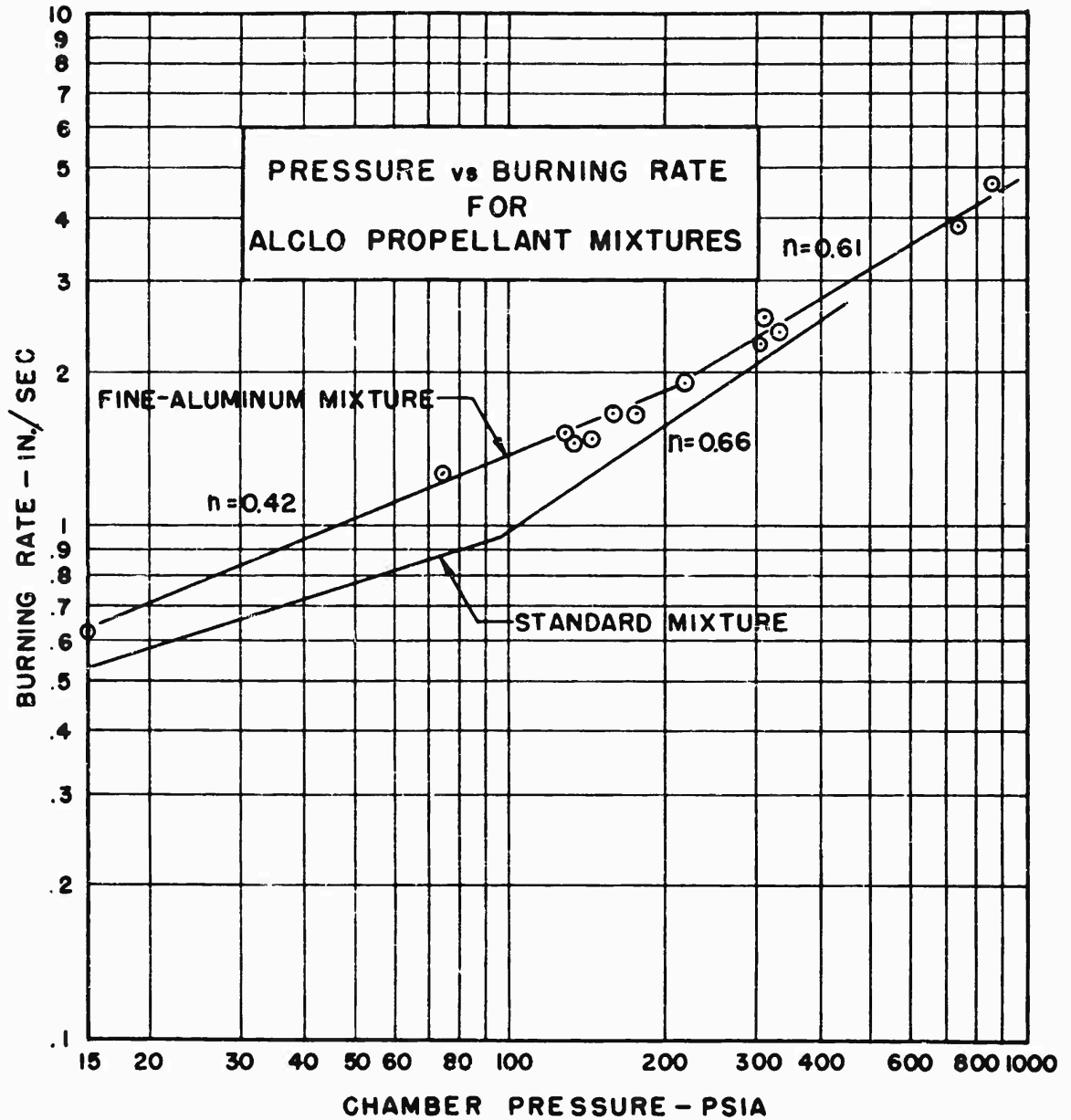


SEALED TUBE HEAT CHARGE



ALCLO HEAT CHARGE

C-4152 12-23-52 BK HMM



FINE-ALUMINUM MIXTURE

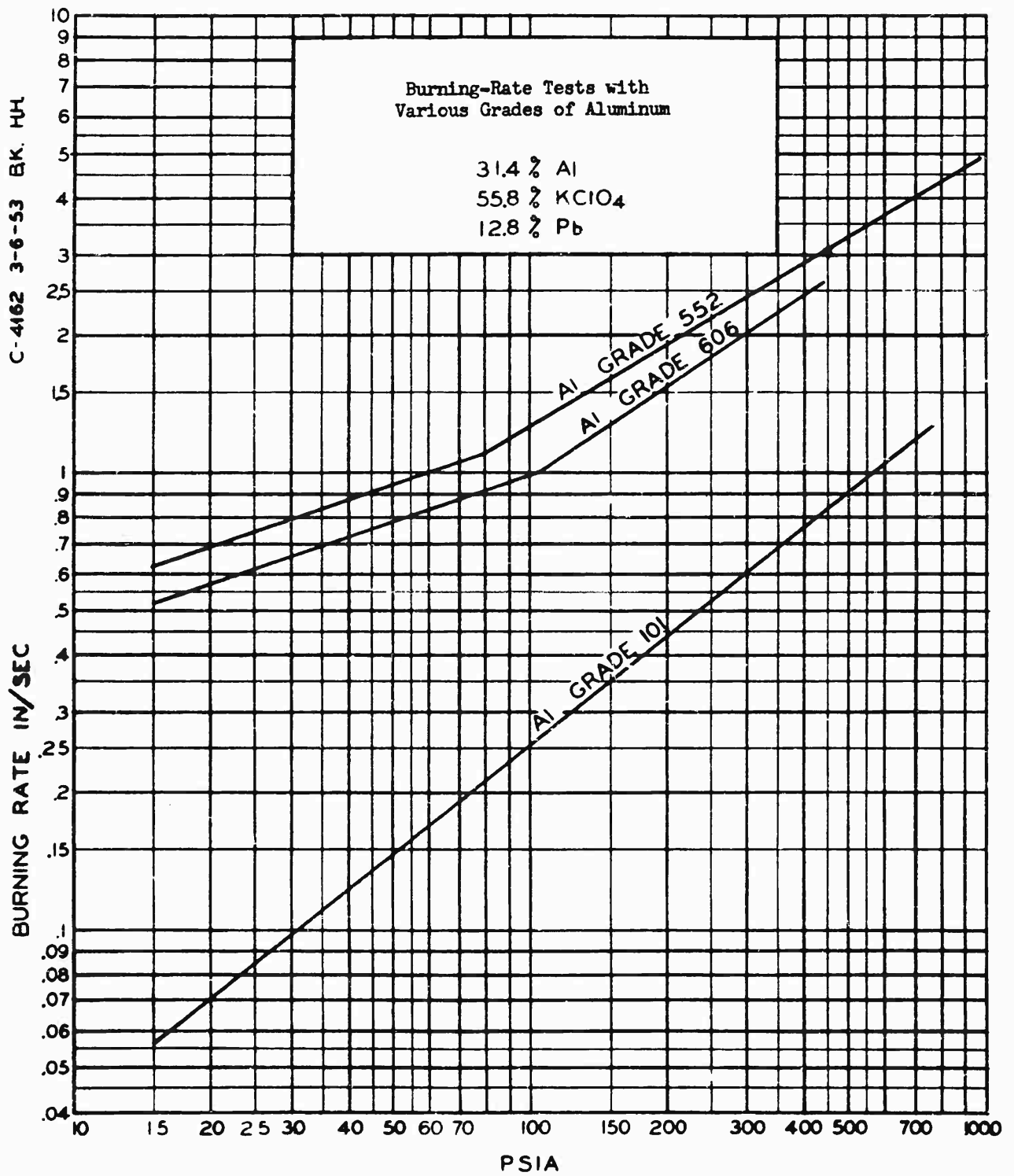
AL # 552	31.4 %
KClO ₄	55.8 %
Pb	12.8 %

STANDARD MIXTURE

AL # 606	31.4 %
KClO ₄	55.8 %
Pb	12.8 %

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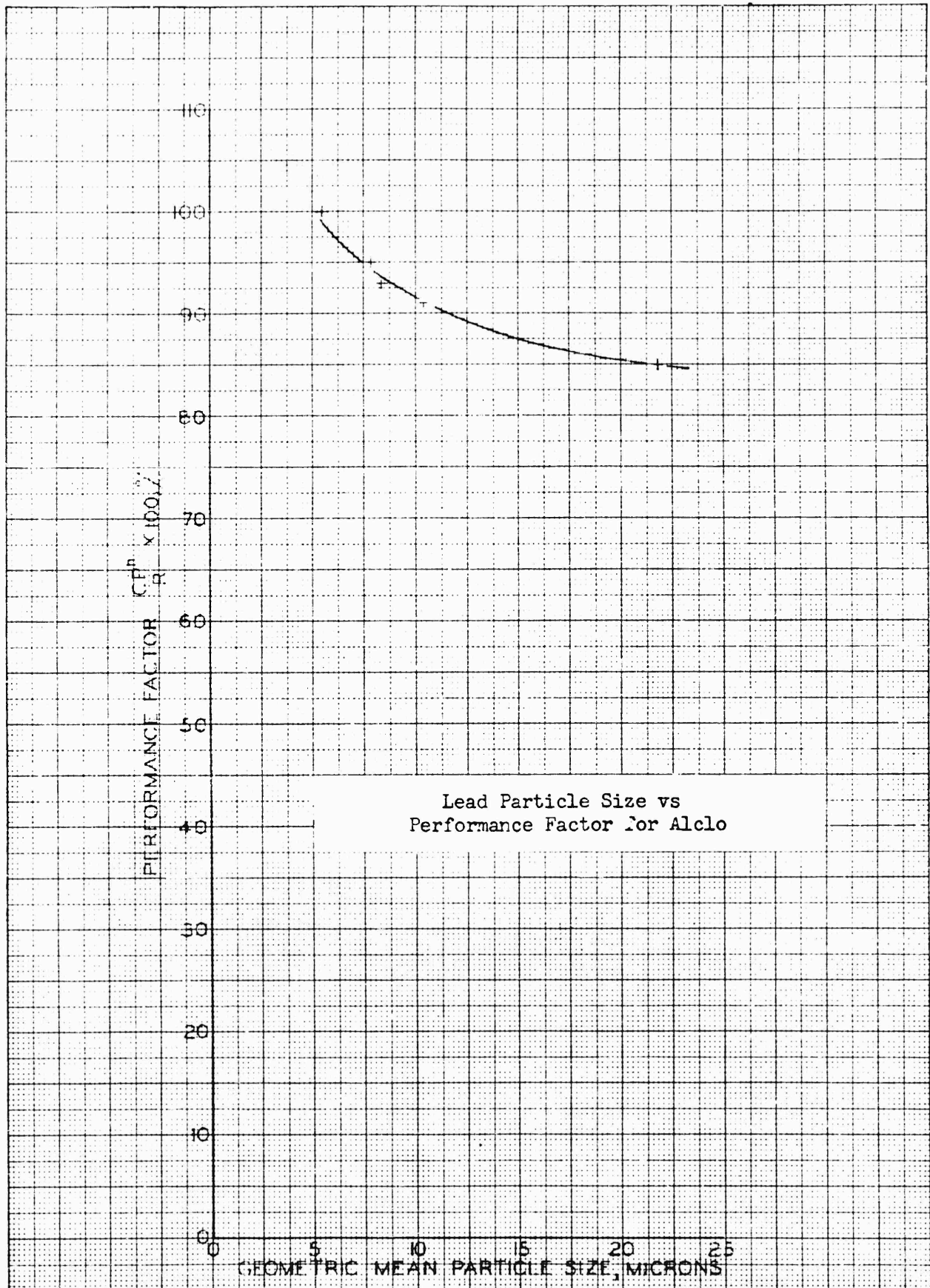
Report No. 1106



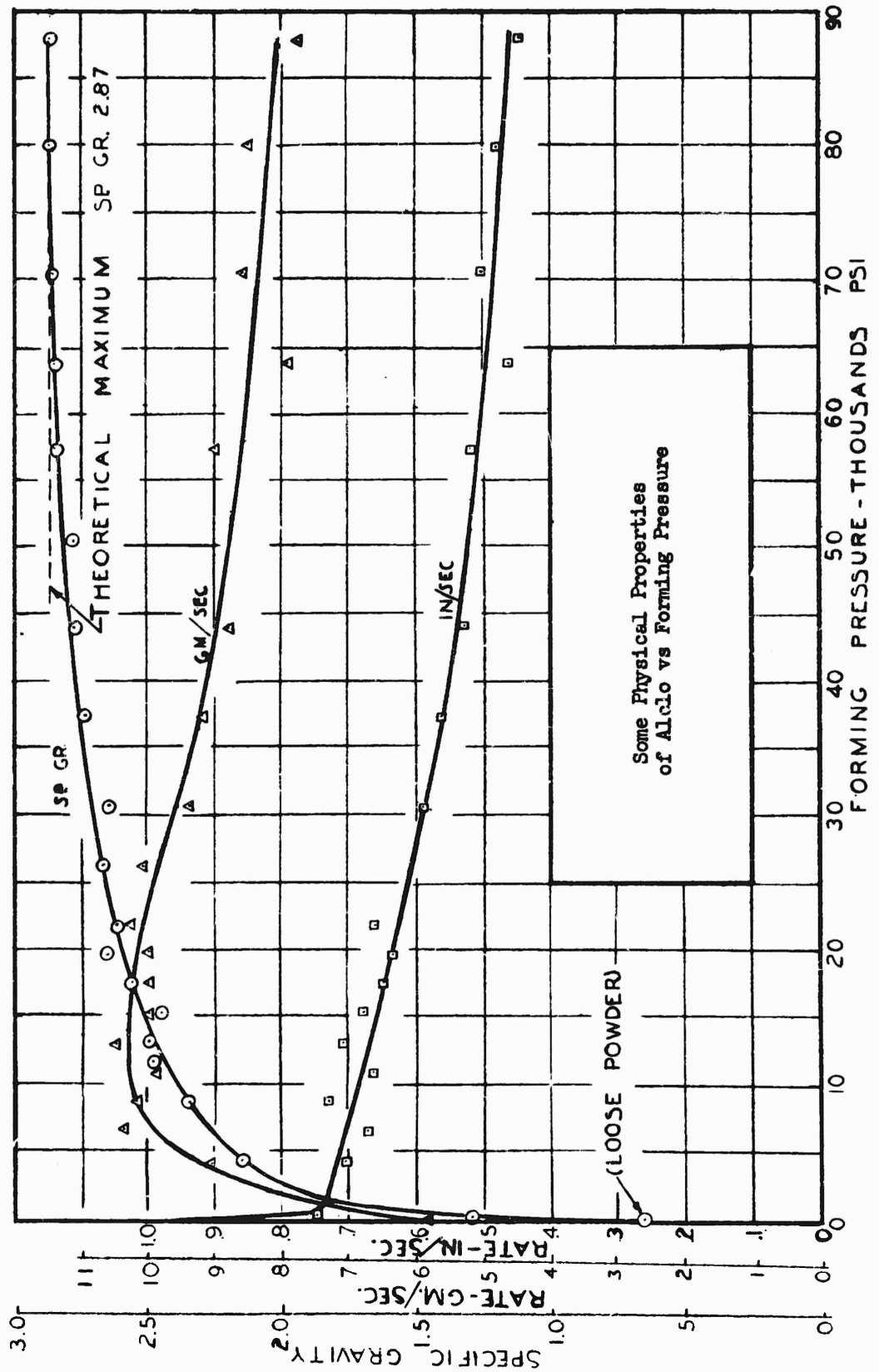
CONFIDENTIAL

Figure 126

C 4.017 7 2-53 E.S./K

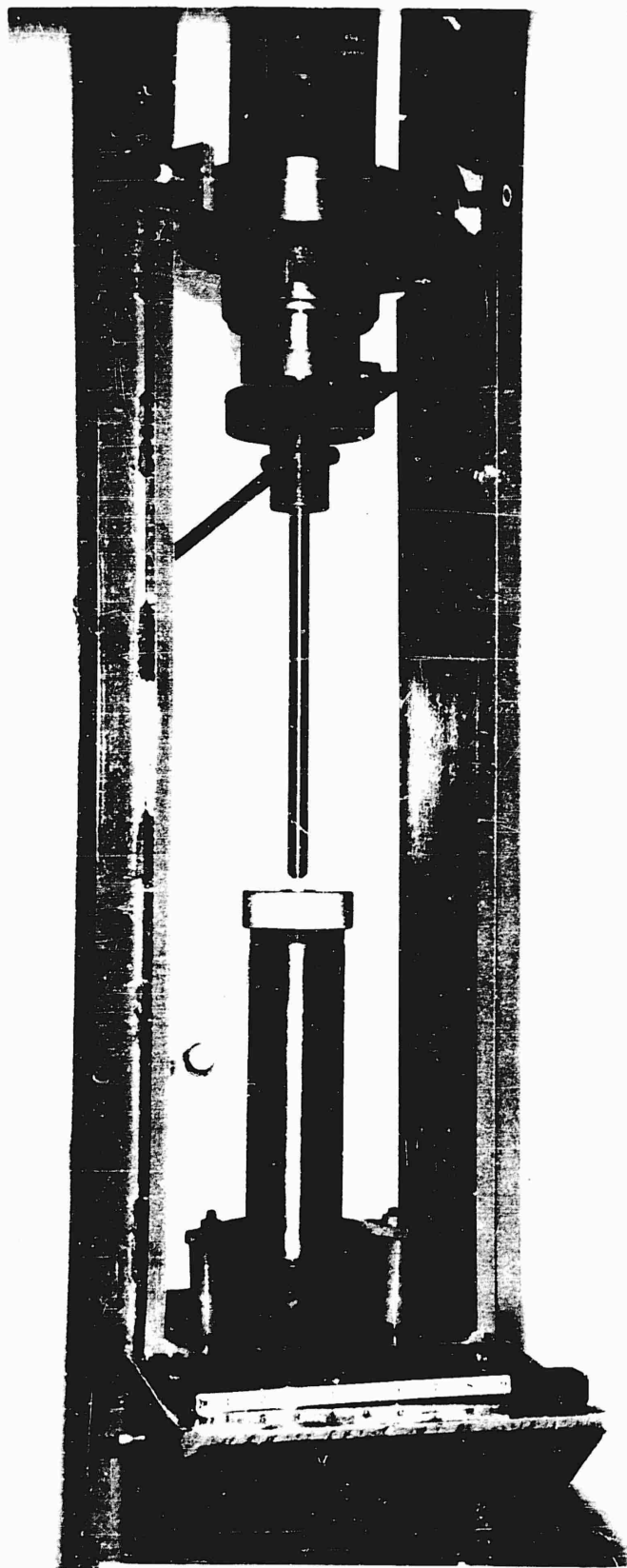


CURVE NO. 4097 7-12-51 HIGGINS / p.m.



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Report No. 1106

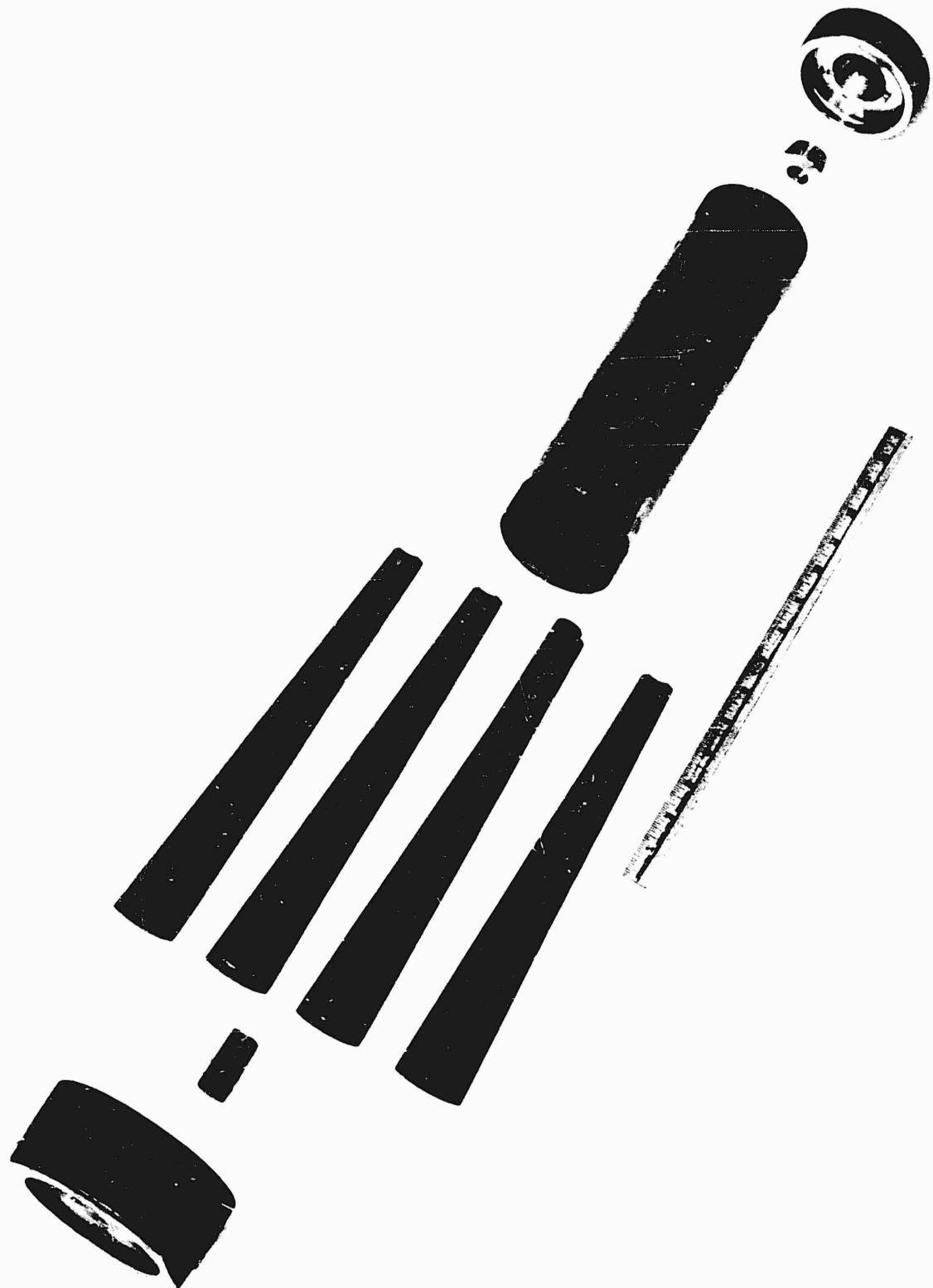


0652-307

20-Ton Alclo Compaction Press

Figure 129

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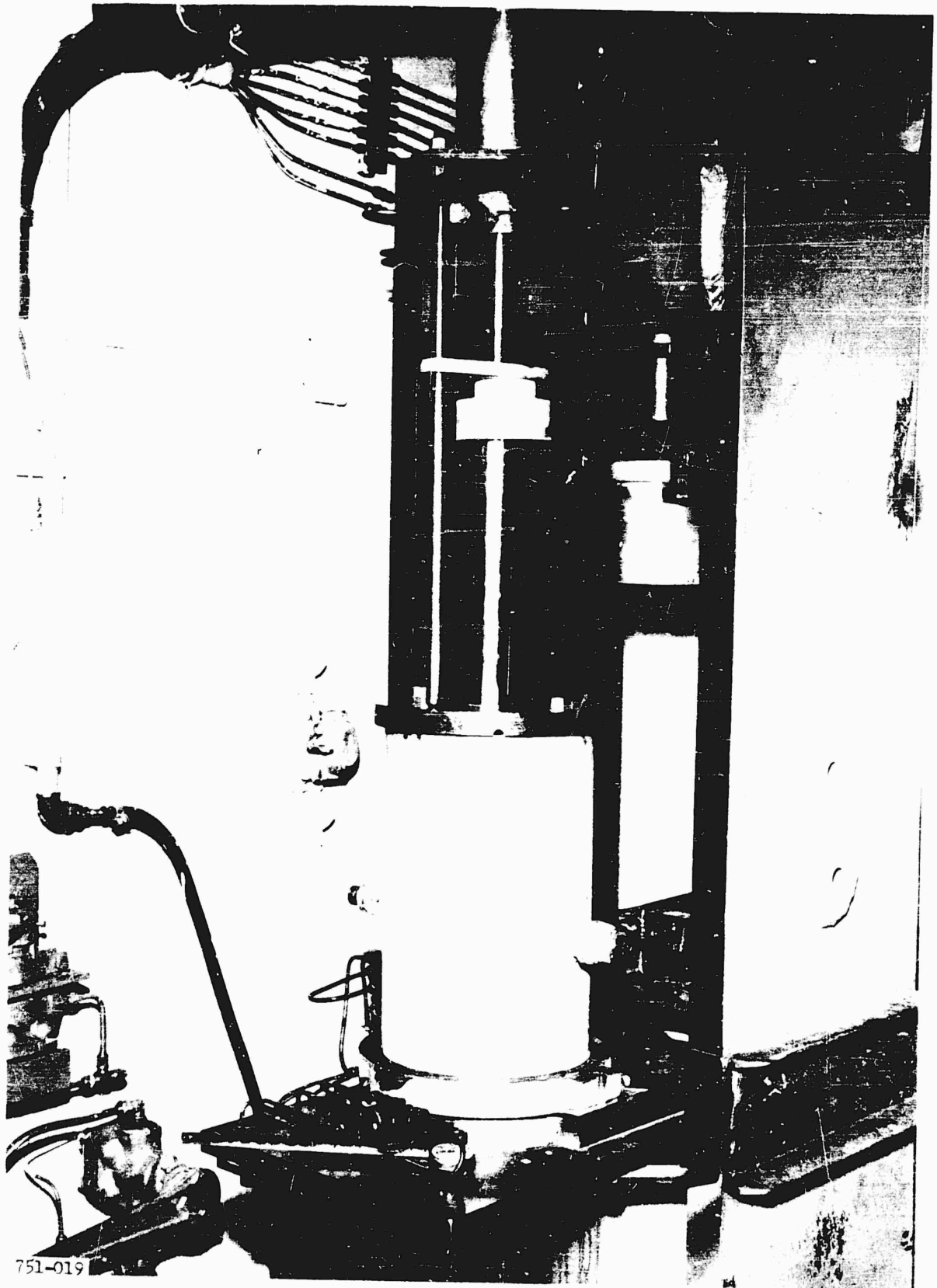


20-Ton Press, Die

Figure 130

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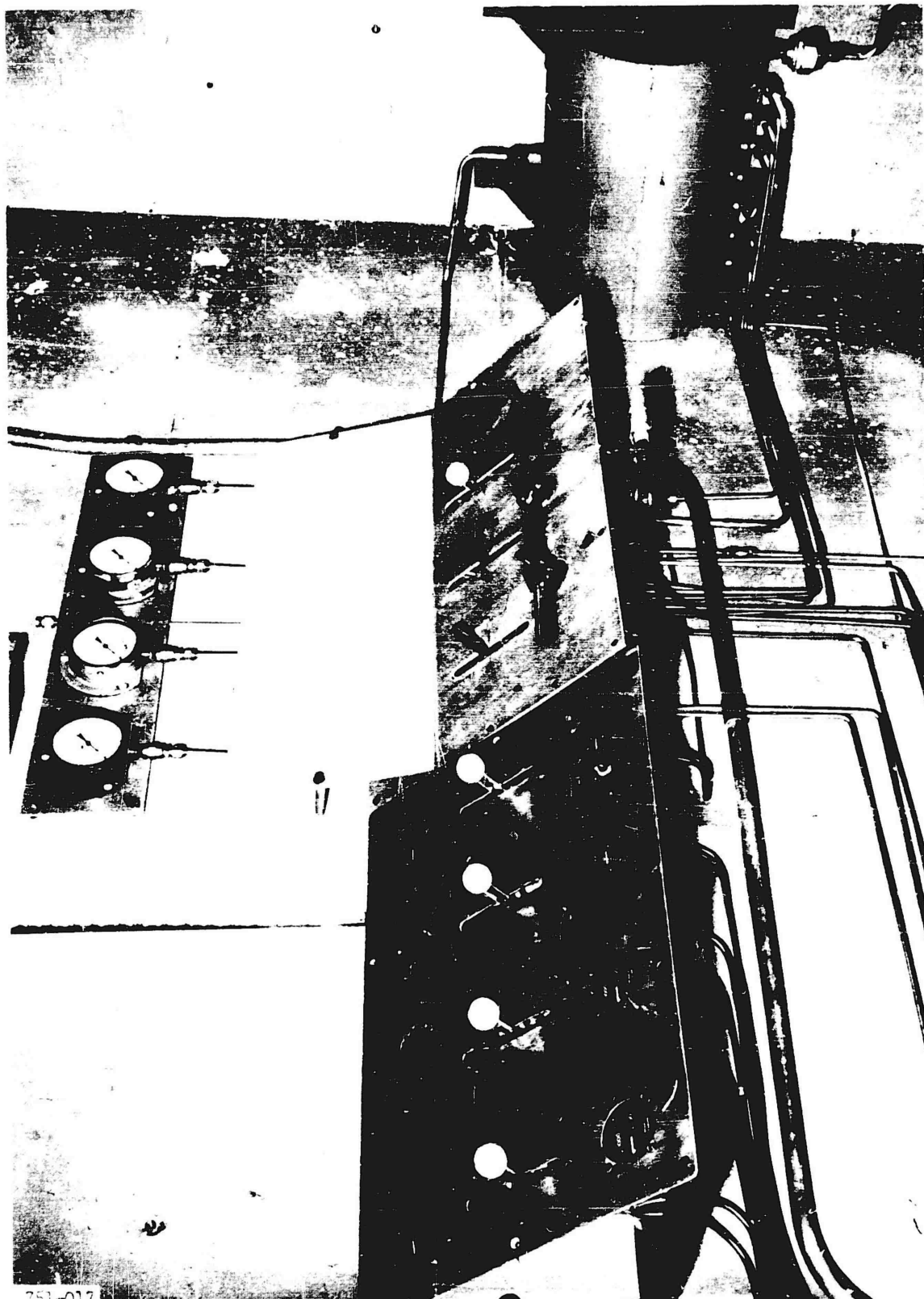
Report No. 1106



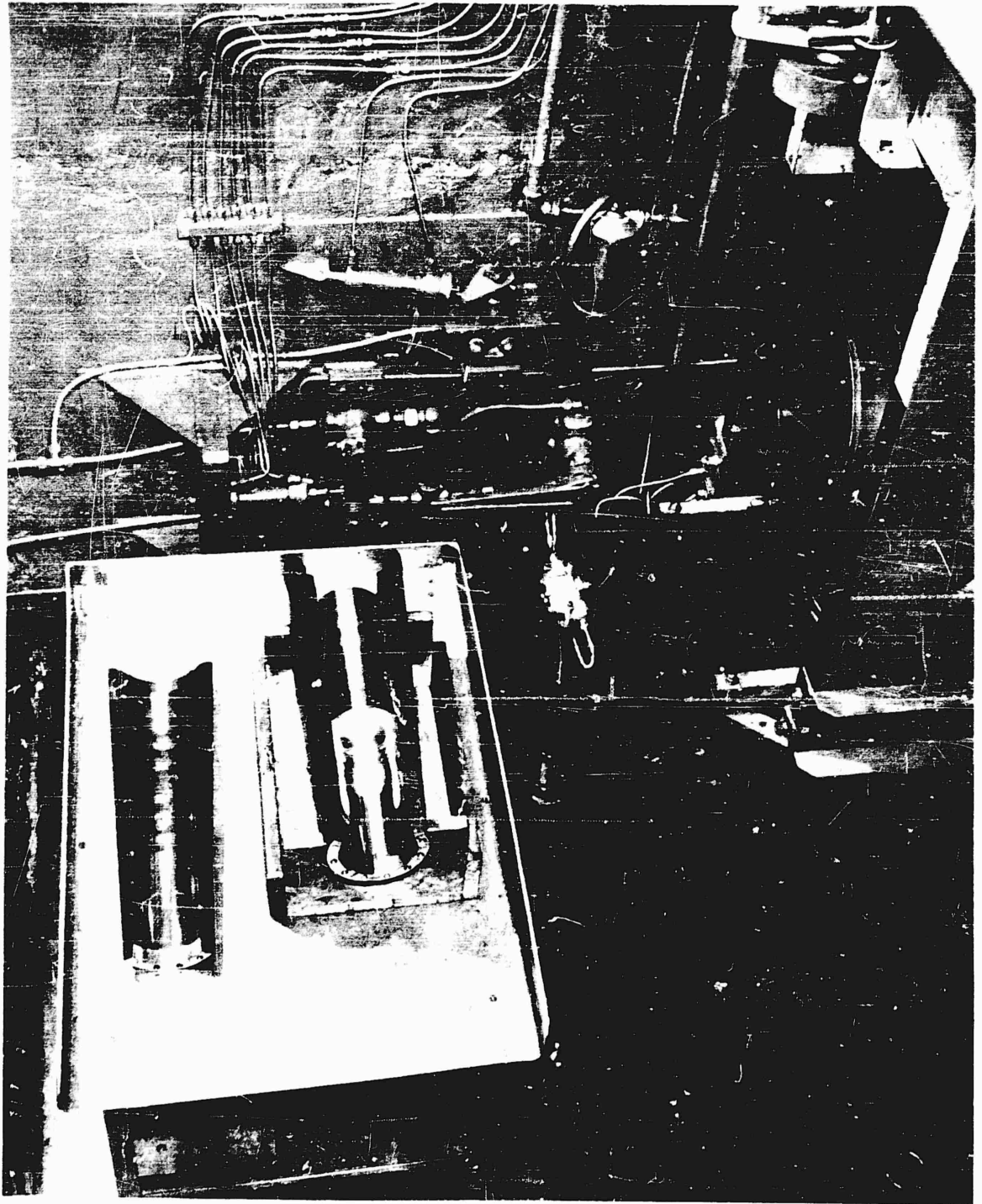
Hydraulic Insertion of 2-in. Plunger

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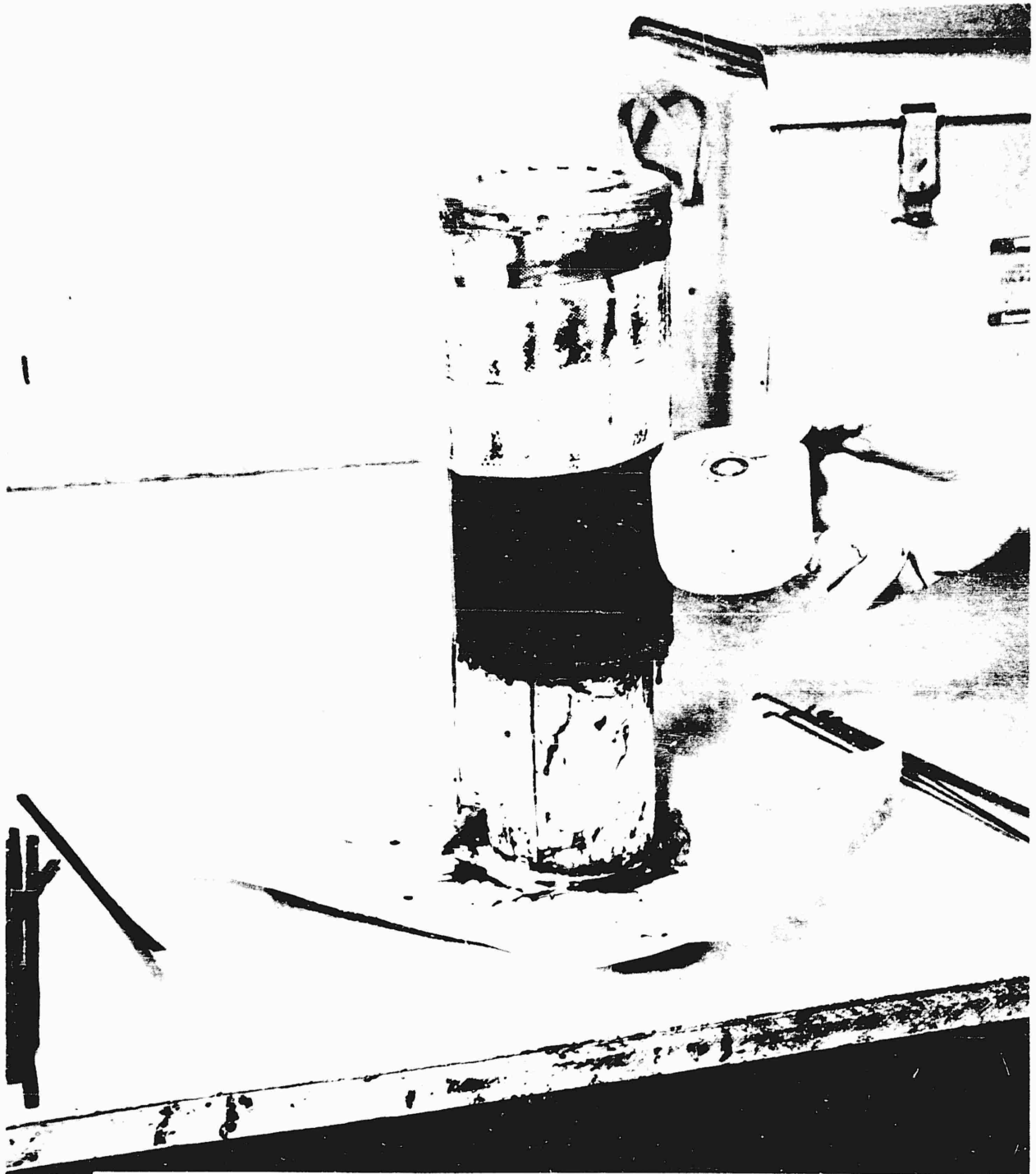
Figure 131



400-Ton Press Control Panel

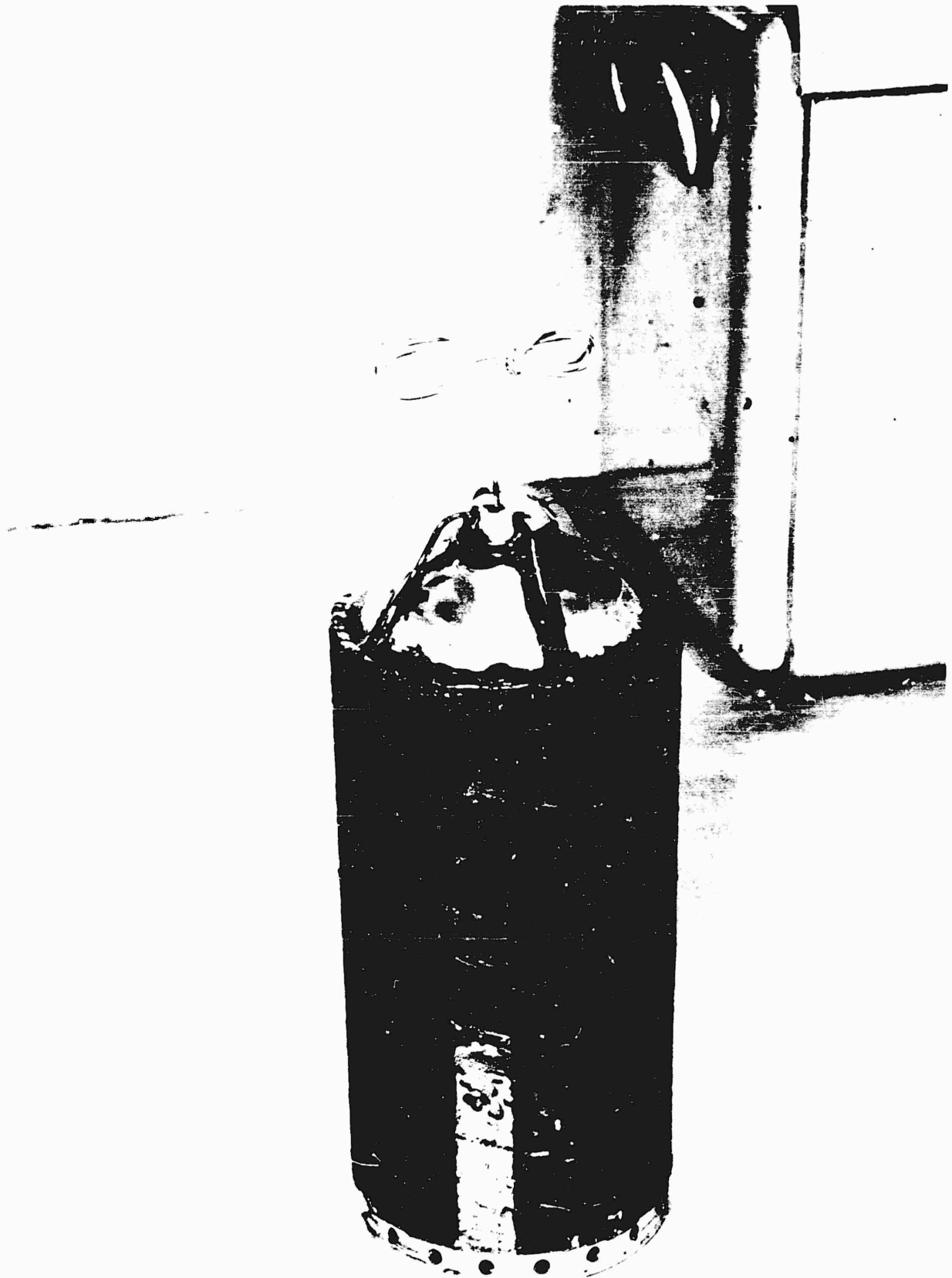


Partial View of Room for 400-Ton Press



654-823

Application of Restriction to the Alclo Grain



67-100

Application of Restriction to the Alclo Grain

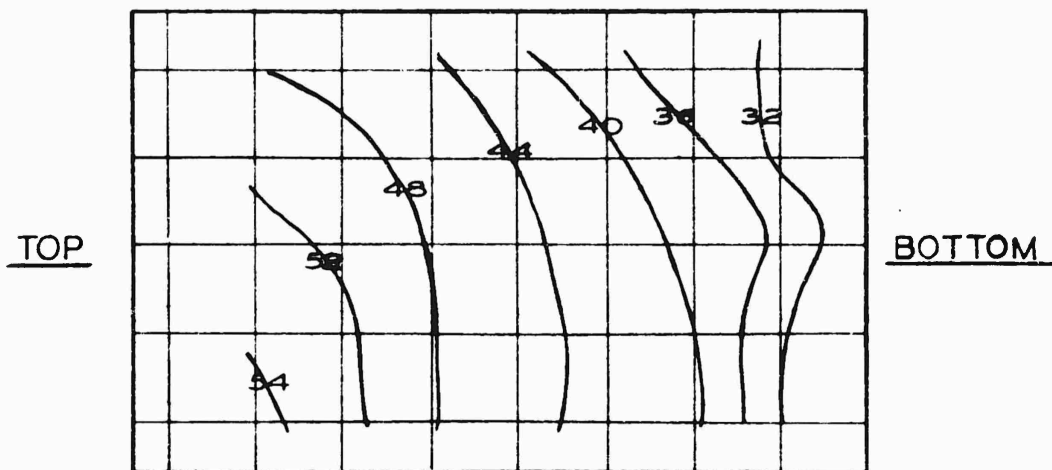
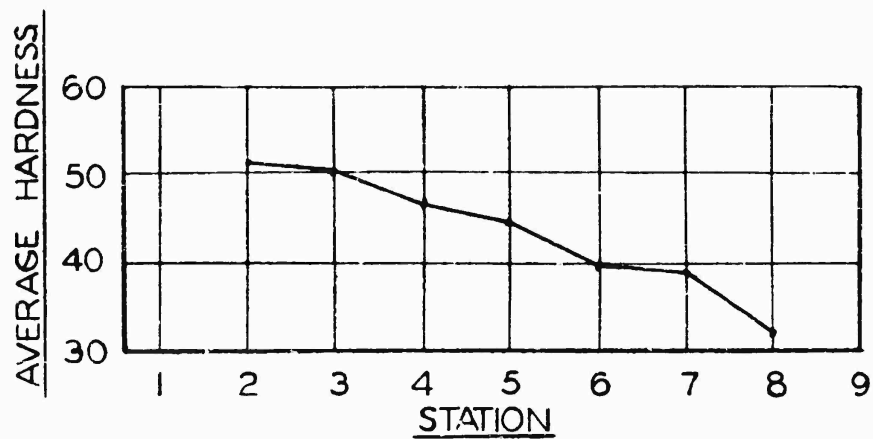
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Figure 135

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Report No. 1106

CURVE NO. 4114



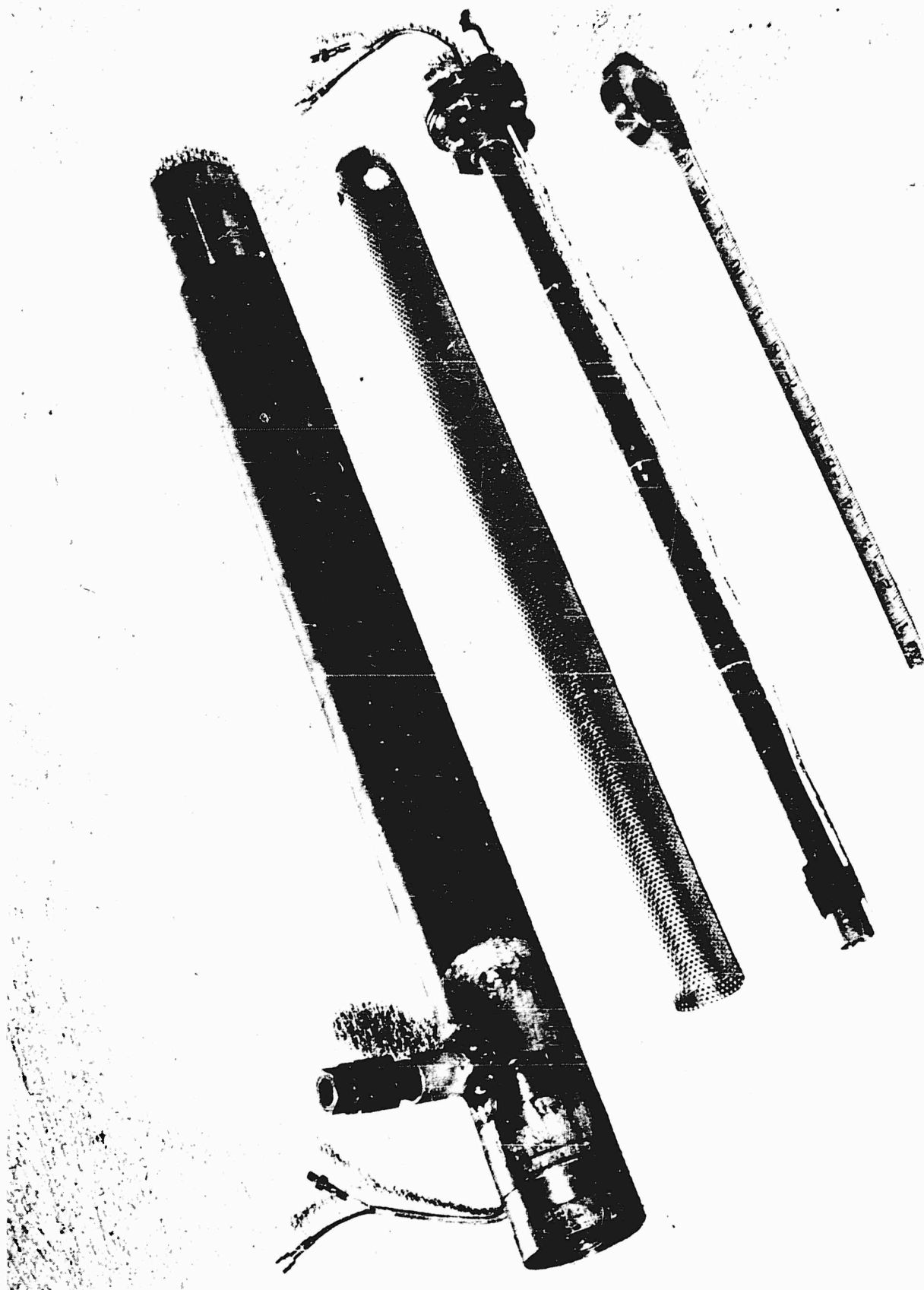
Hardness Contours of 0.75-in. Grain

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Figure 136

CONFIDENTIAL

Report No. 1106



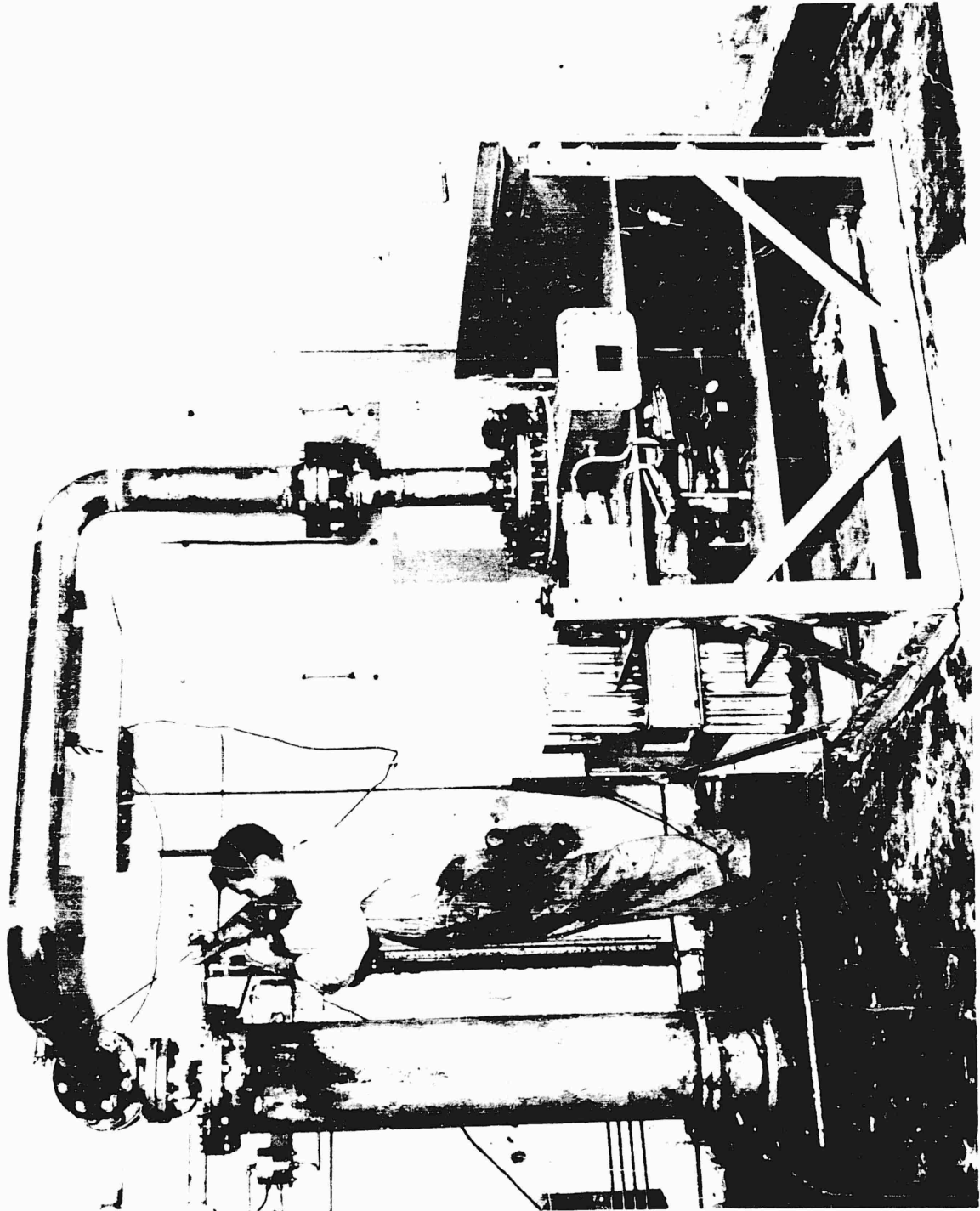
Components of Vertical Alclo-Fueled Steam Generator, Mark II

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Figure 137



Disassembled View of the Vertical Shock Generator, Mark III



General View of the Vertical Steam Generator, Mark III

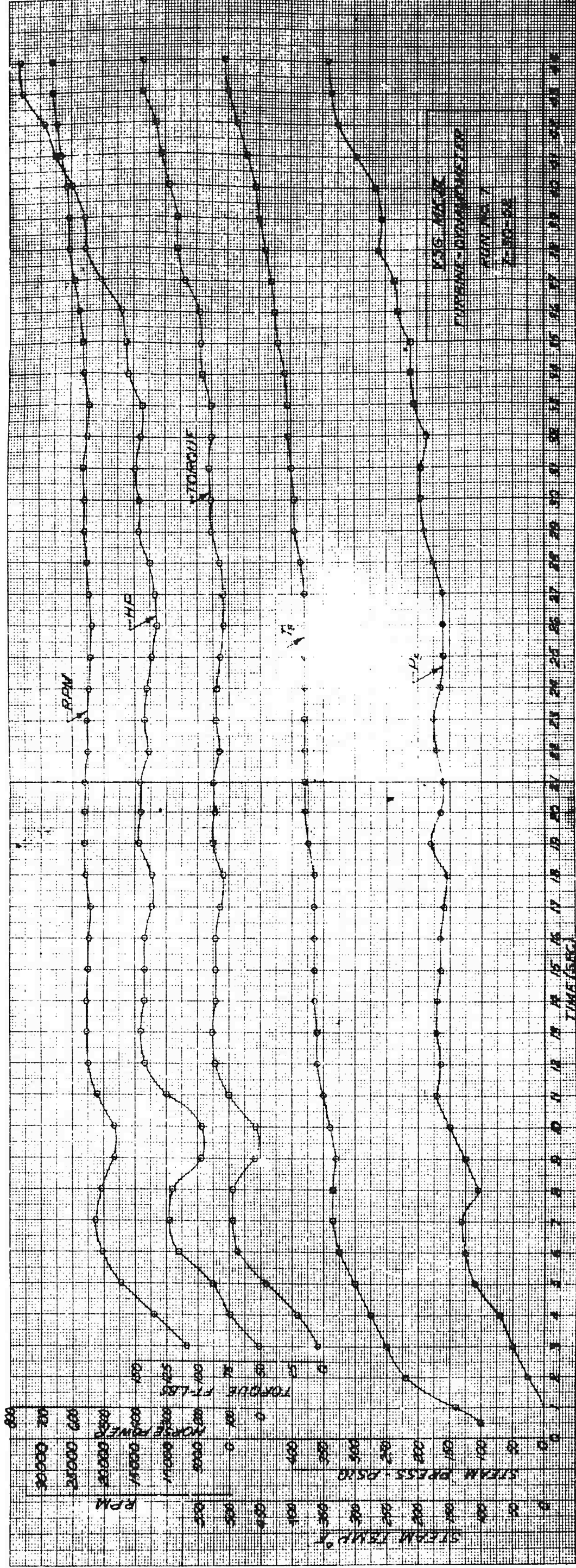


Figure 111

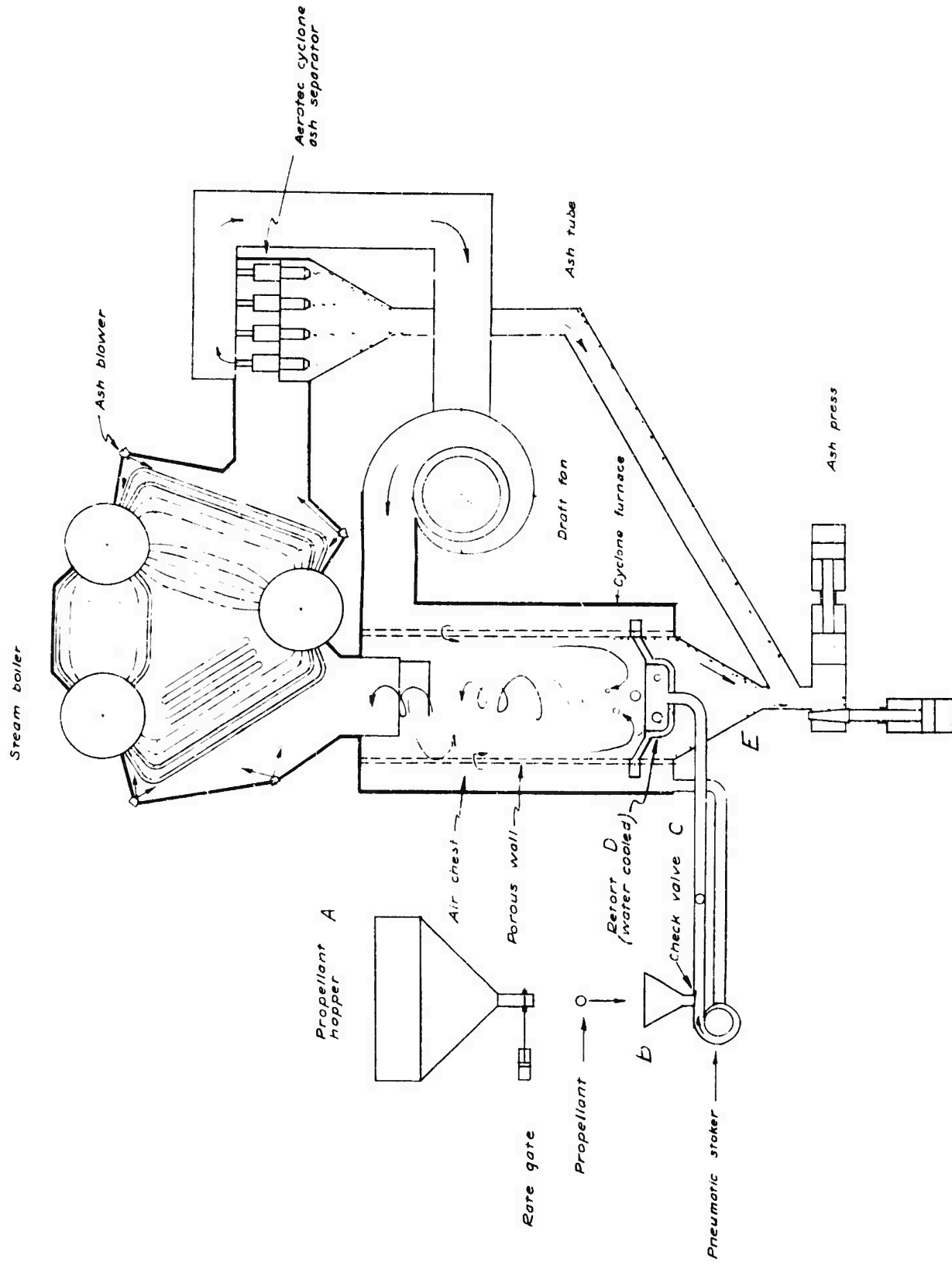
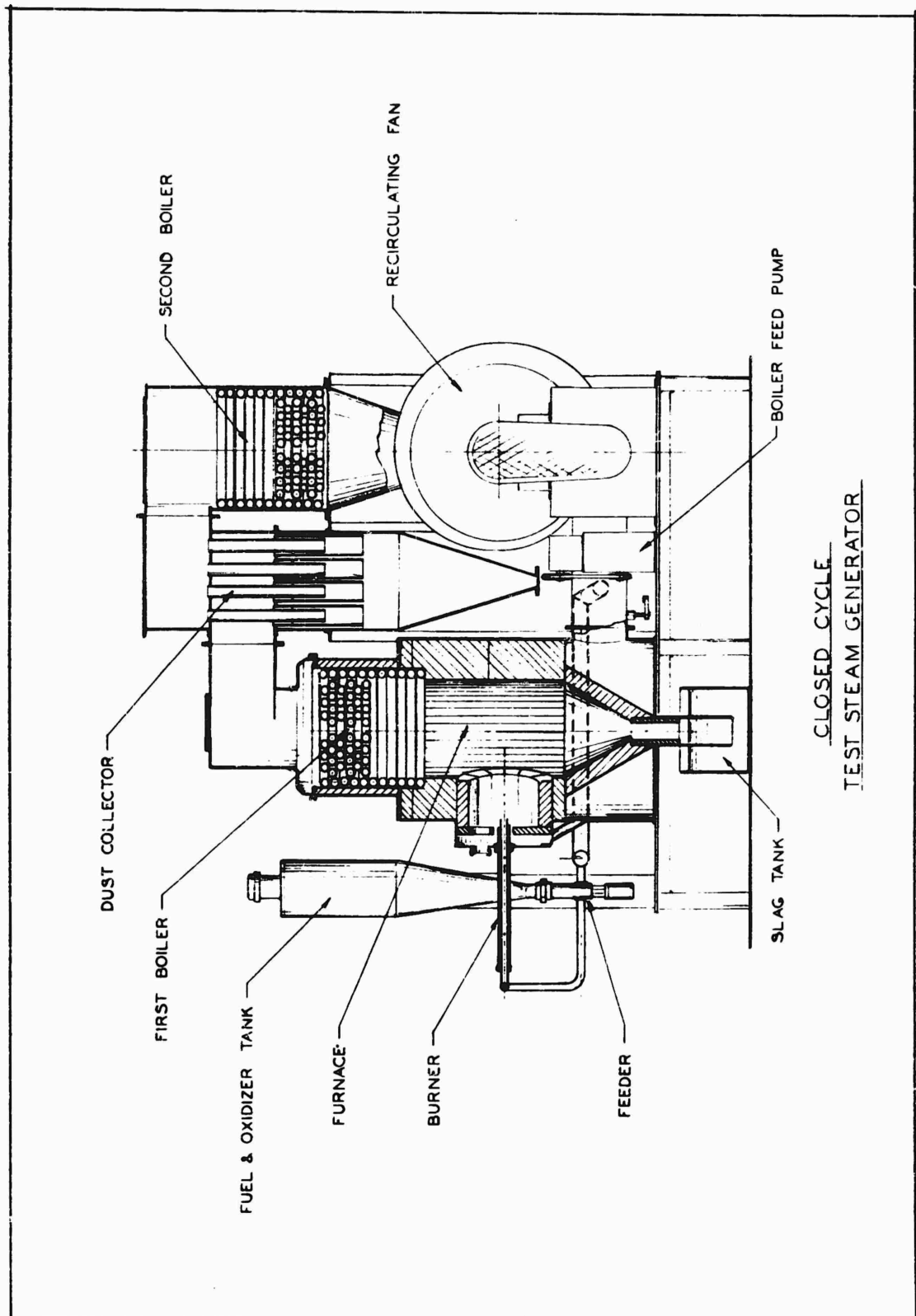


Diagram of an Alcl₃-O-Fueled Submarine Power Plant

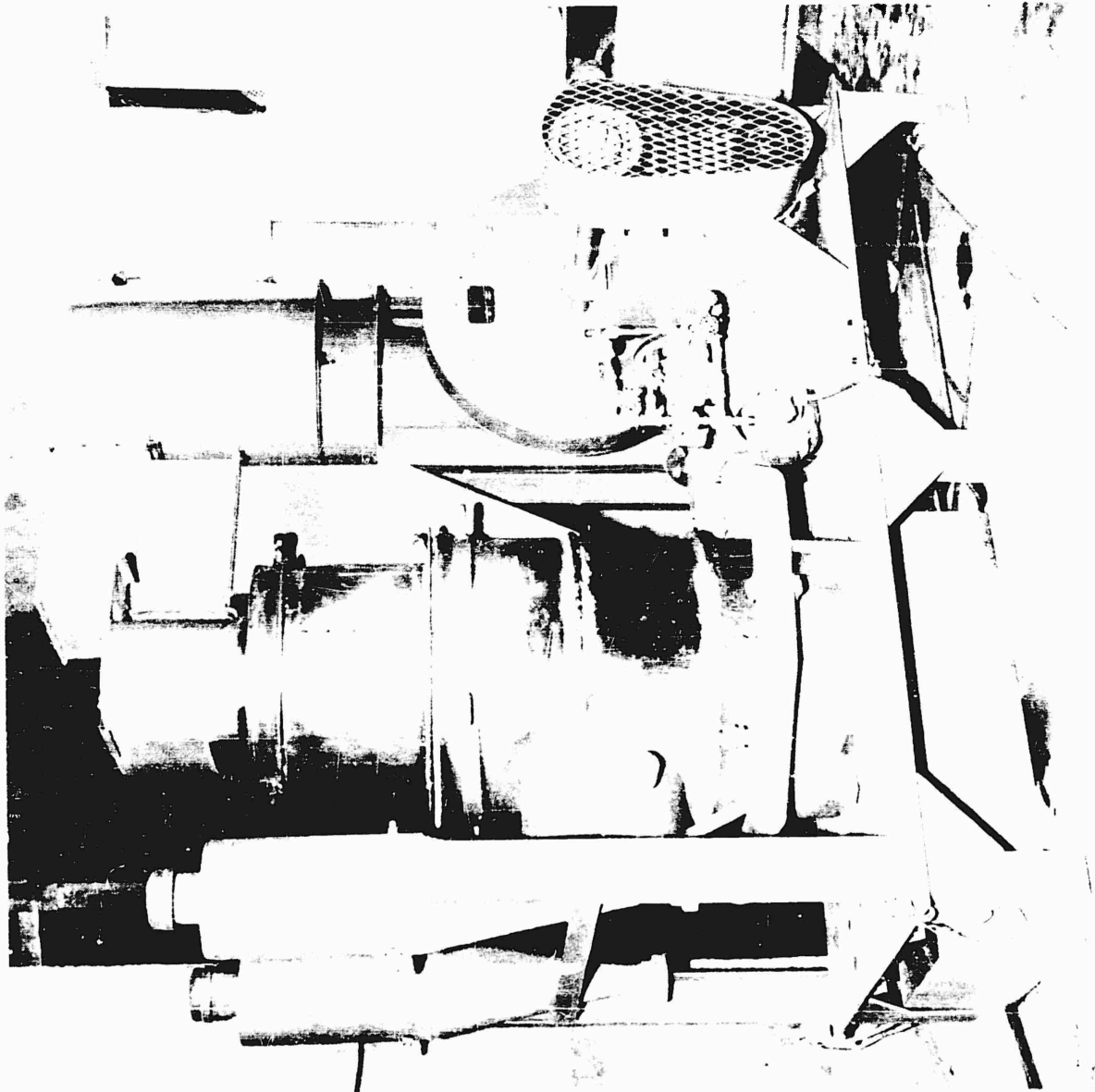
HEAT TREAT		FINISH		NO. DES.		NEXT ASSY.		MATERIAL		DRAWING FILE		R	
EFFECT DATE				CALCULATED WEIGHT						5-2-50			
				ACTUAL WEIGHT						Krytox			
								DRAFTSMAN		CHECKED		STRESS	
								SCALE		ENGINEER		APPROVED	
ALROJET ENGINEERING CORP.										ALROJET ENGINEERING CORP.			
INDICATES SURFACE ROUGHNESS										ALROJET ENGINEERING CORP.			
FINISH PER MIL-STD-1302 D-REVISION NONE										ALROJET ENGINEERING CORP.			
HEAT TREAT		FINISH		NO. DES.		NEXT ASSY.		MATERIAL		DRAWING FILE		R	
EFFECT DATE				CALCULATED WEIGHT						5-2-50			
				ACTUAL WEIGHT						Krytox			
								DRAFTSMAN		CHECKED		STRESS	
								SCALE		ENGINEER		APPROVED	
ALROJET ENGINEERING CORP.										ALROJET ENGINEERING CORP.			
INDICATES SURFACE ROUGHNESS										ALROJET ENGINEERING CORP.			
FINISH PER MIL-STD-1302 D-REVISION NONE										ALROJET ENGINEERING CORP.			



C-4226 9-18-52 MB

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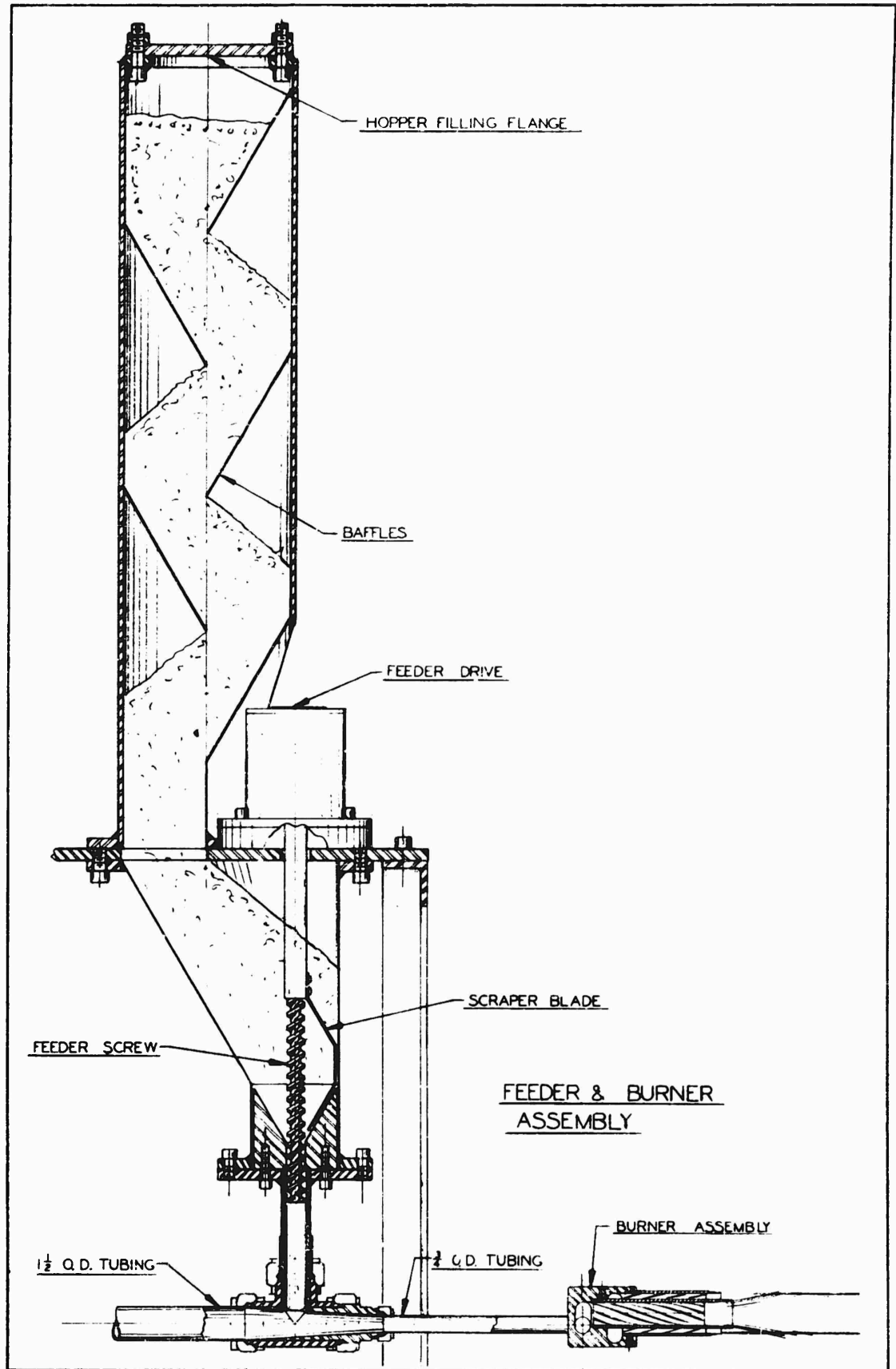
Report No. 1106

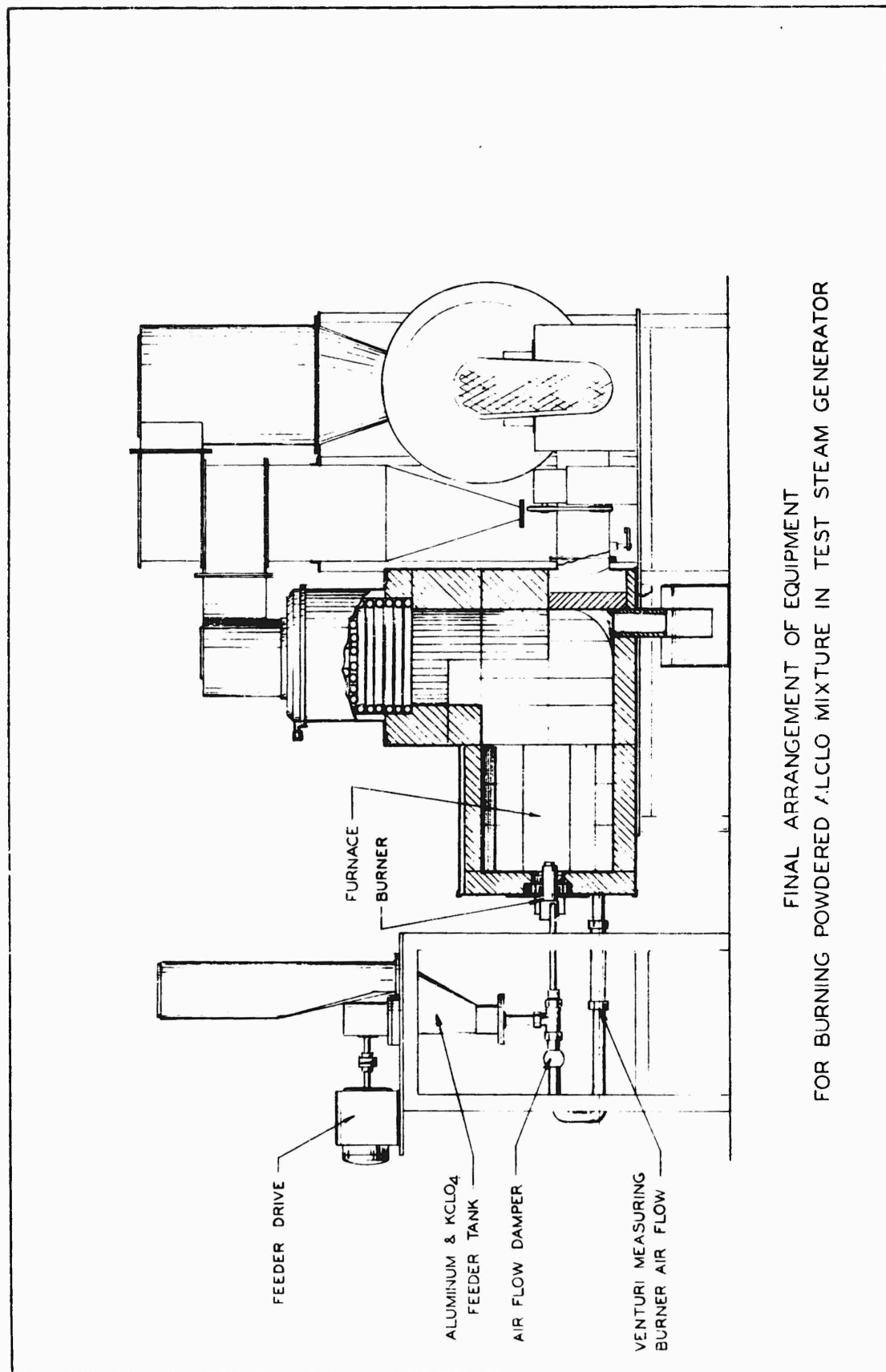


Test Steam Generator

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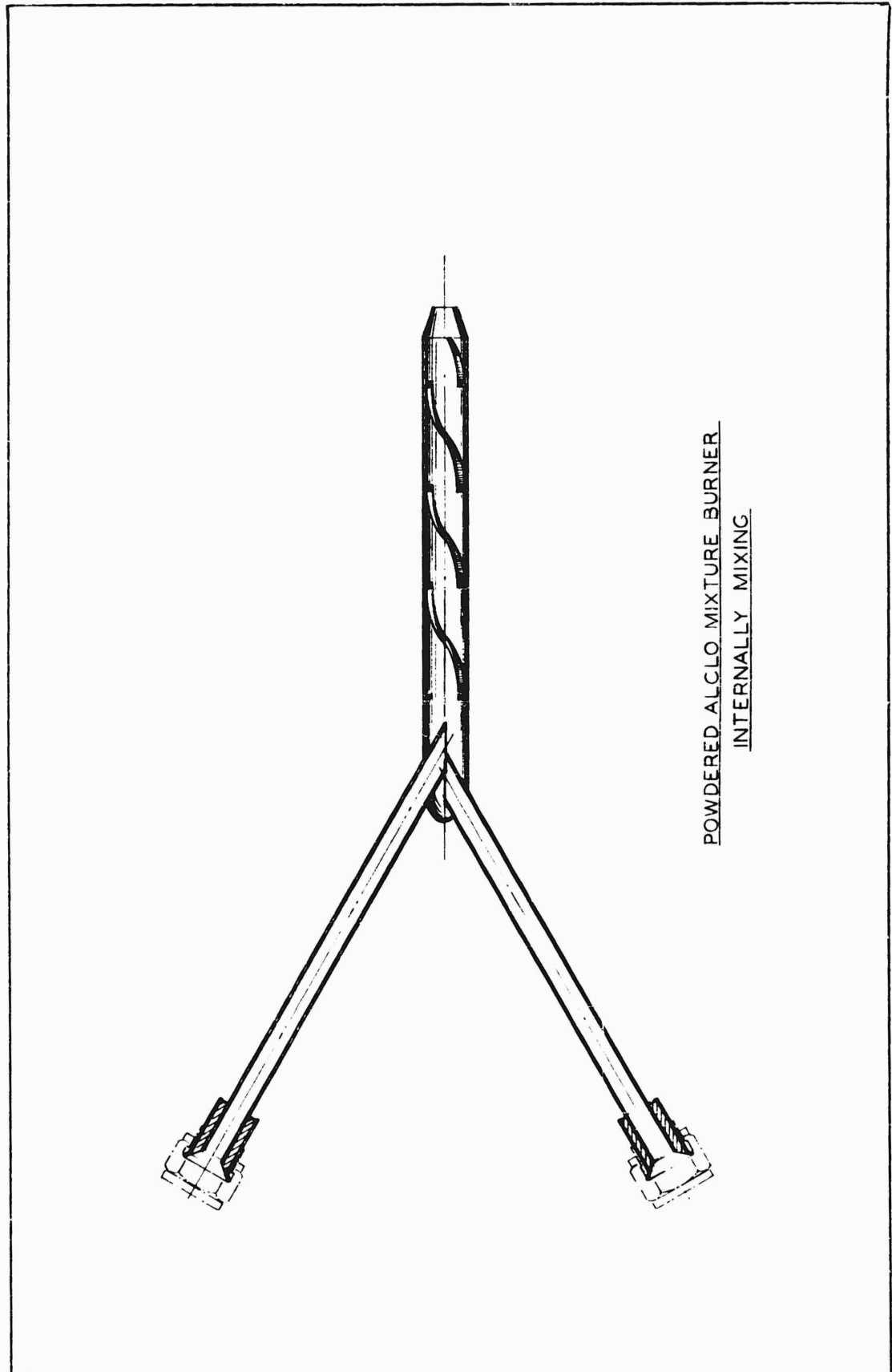
Figure 11h





FINAL ARRANGEMENT OF EQUIPMENT
FOR BURNING POWDERED KClO_4 MIXTURE IN TEST STEAM GENERATOR

C-4227 9-18-53 MB

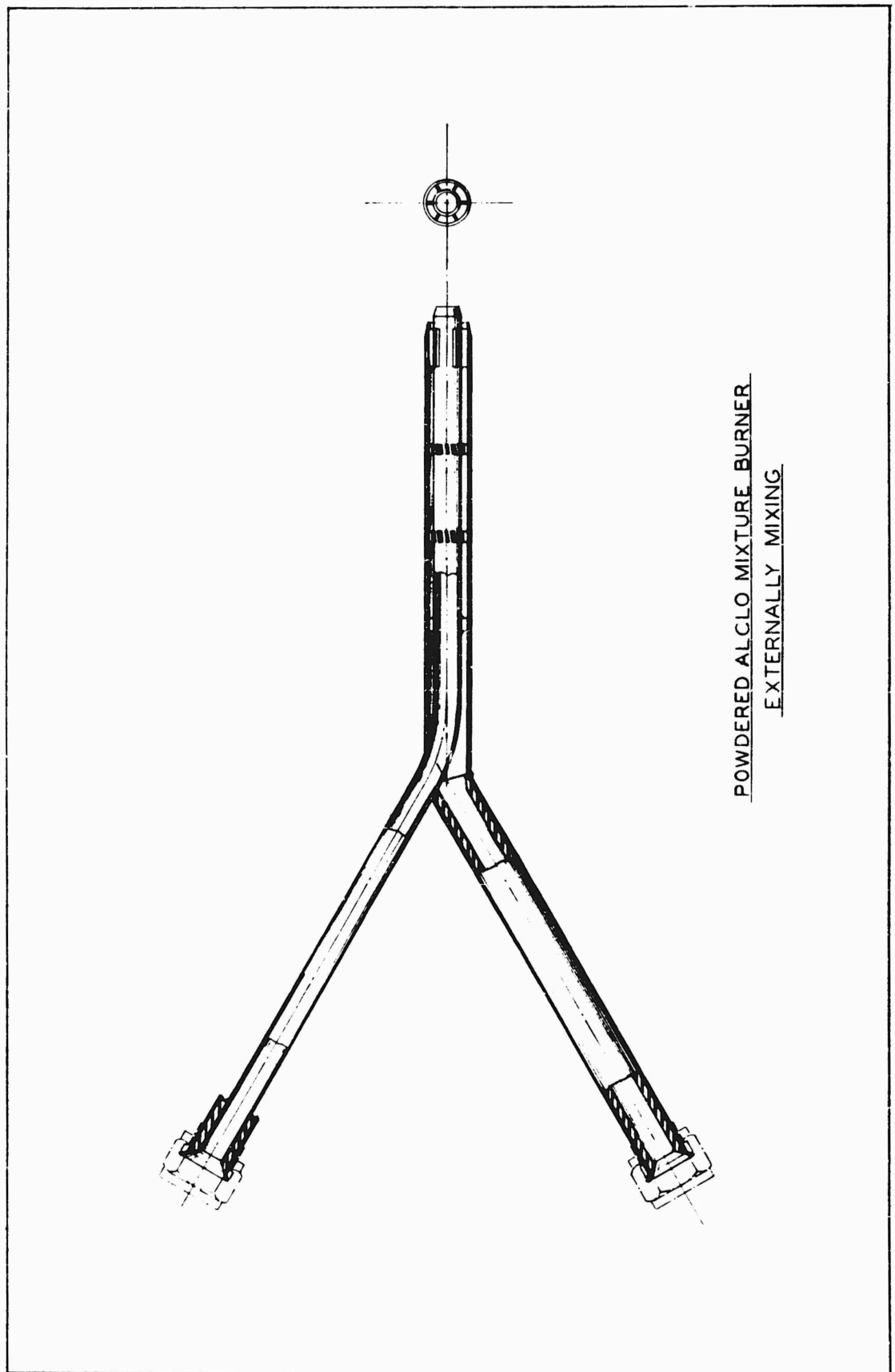


POWDERED ALCLO MIXTURE BURNER
INTERNALLY MIXING

C-4228 9-18-53 MB

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Report No. 1106

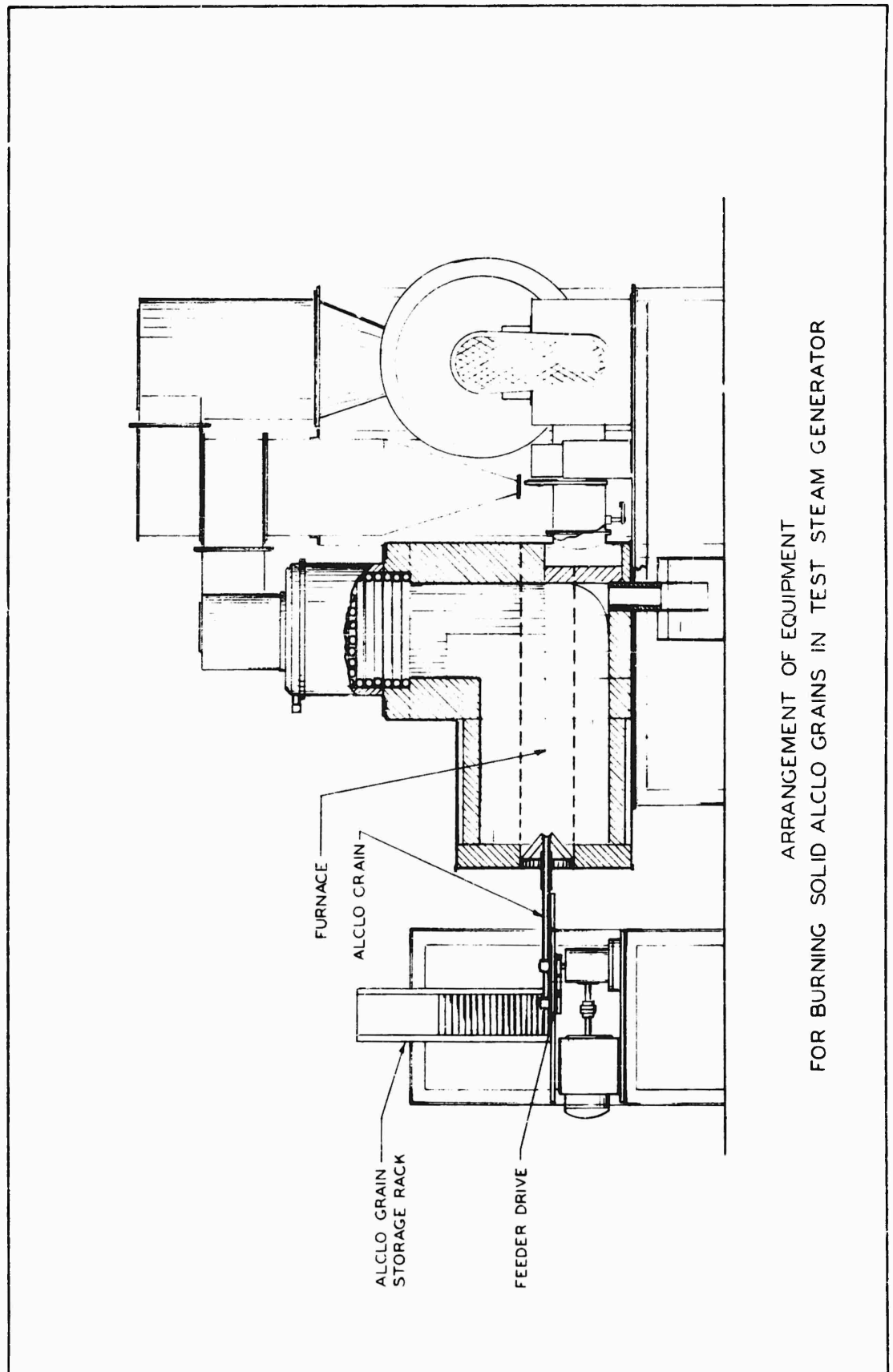


POWDERED ALCLO MIXTURE BURNER
EXTERNALLY MIXING

C-4229 9-18-53 MB

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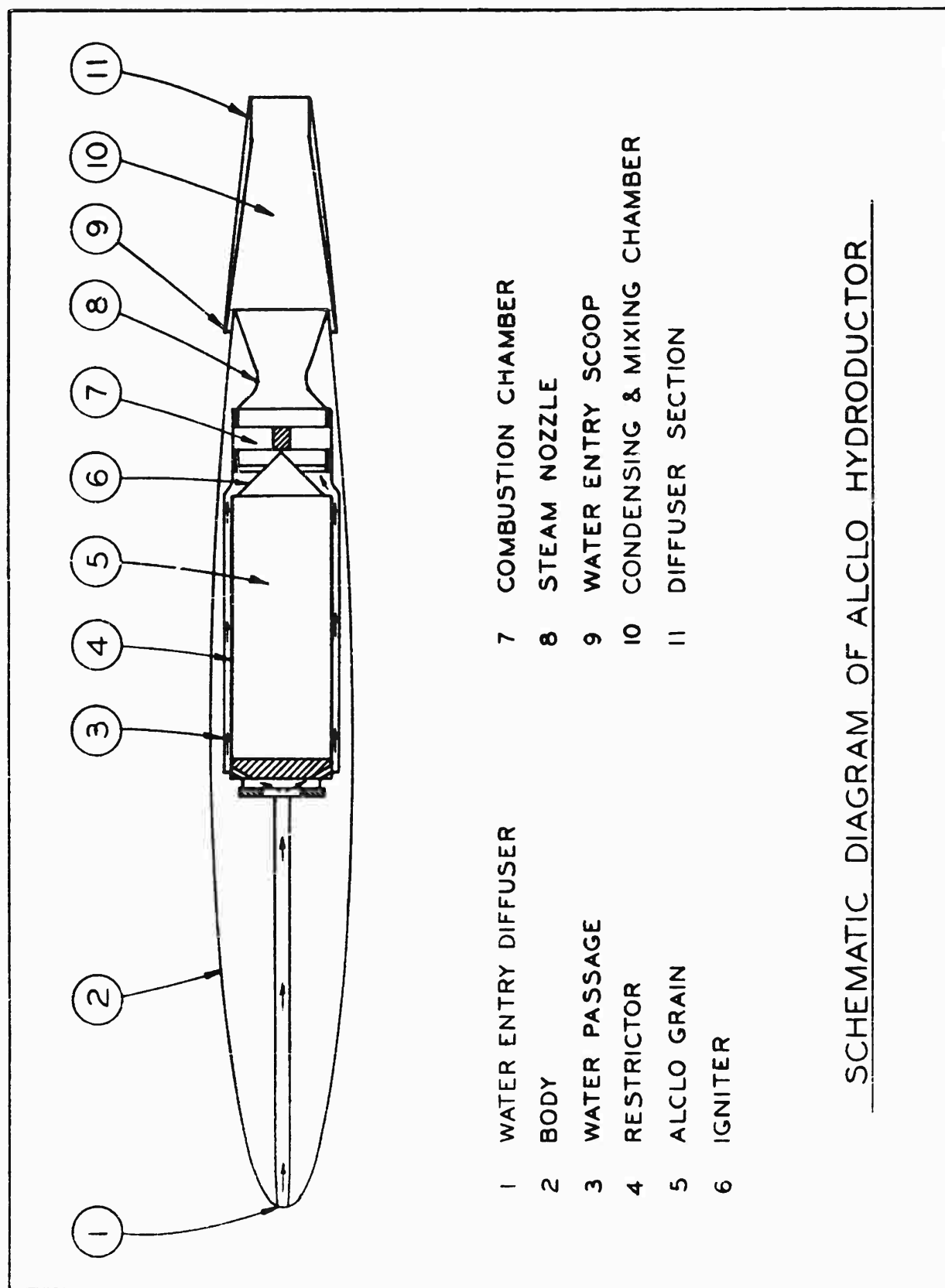
Figure 1148



C-4237

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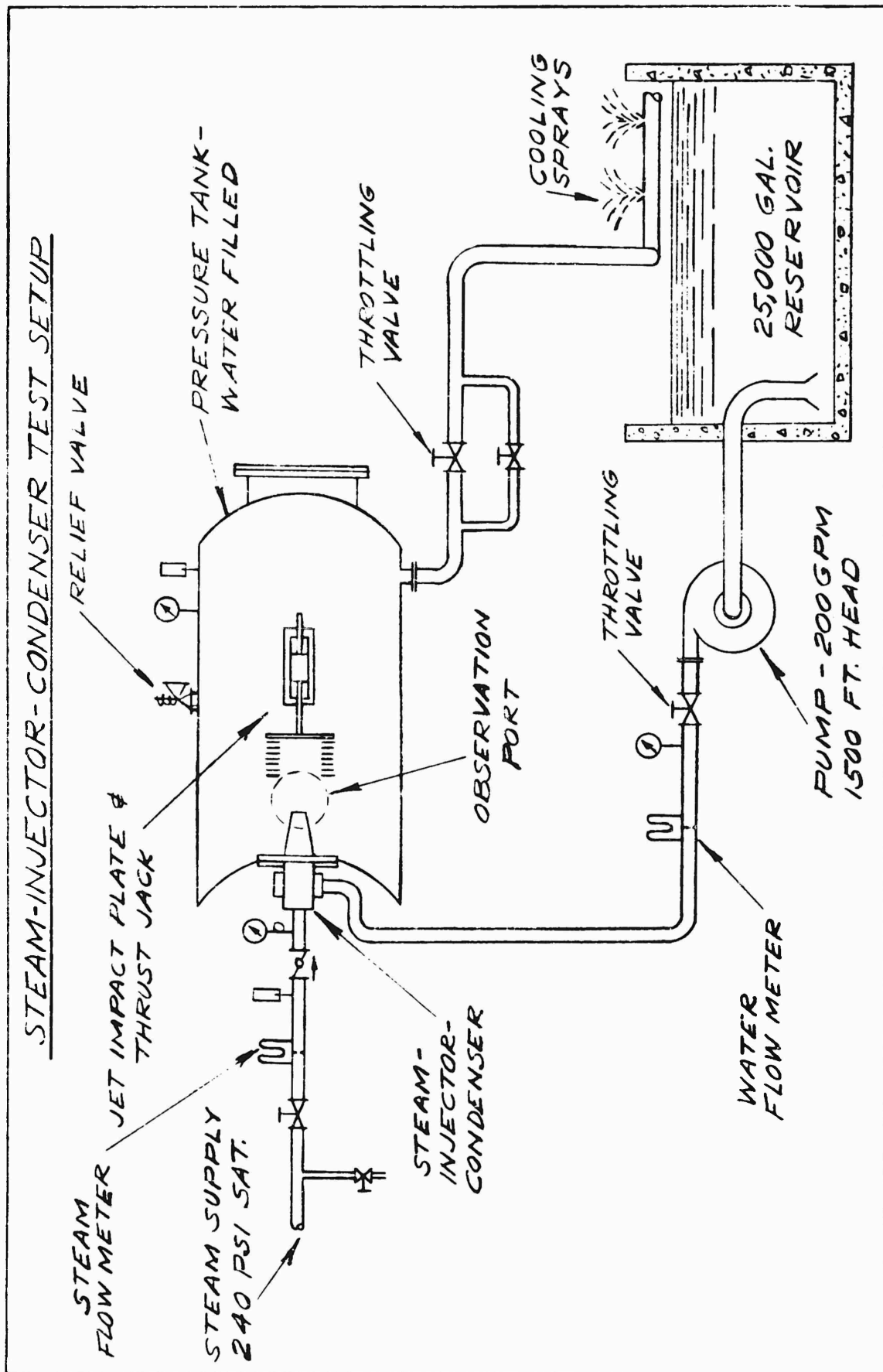
C-4257 6-16-54 EH RS

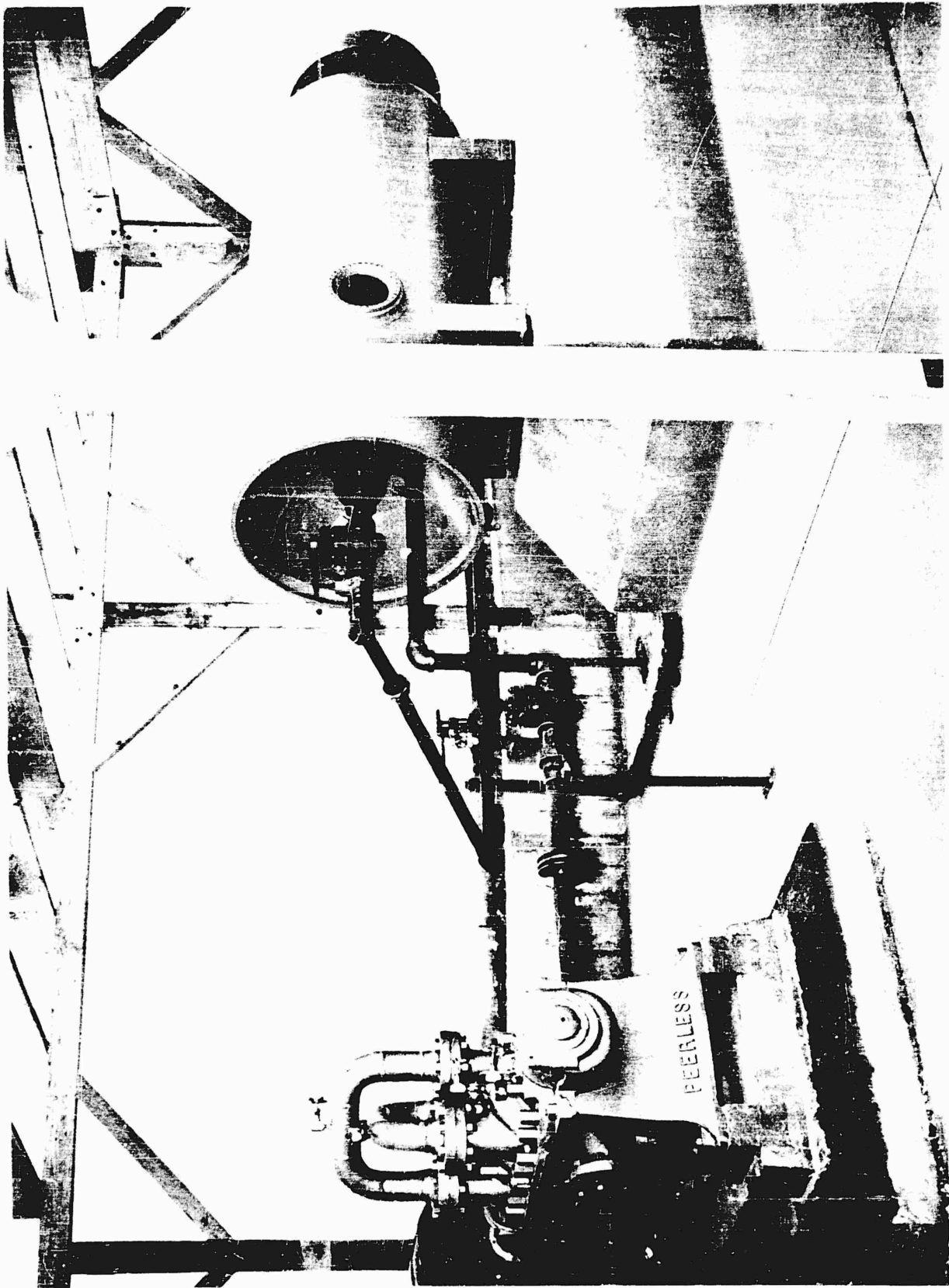


SCHEMATIC DIAGRAM OF ALCLO HYDRODUCTOR

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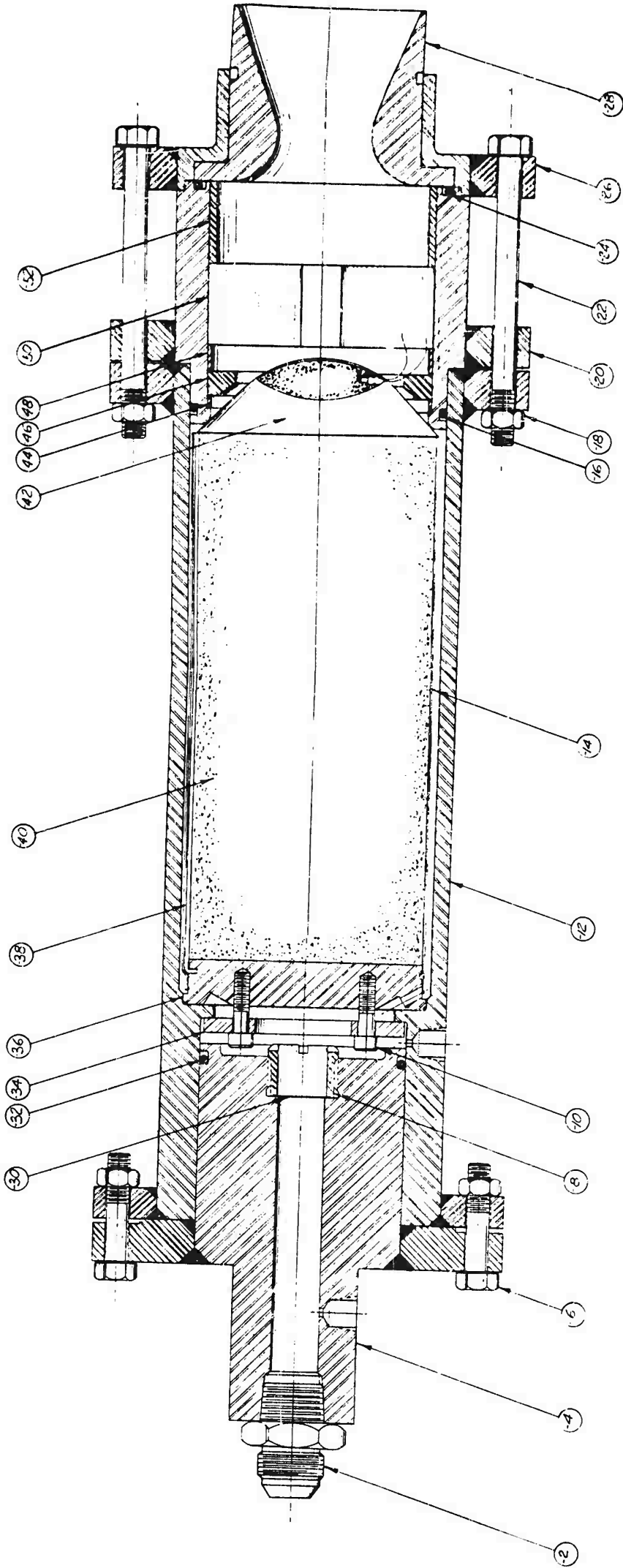
CURVE NO. 4100 7-22-51 EGL





General View of Steam-Injector-Condenser Test Setup

DATE	BY	CHKD



52	1	SPACER	0-000471-6
50	1	BUTTON	0-000472
48	1	SPACER	0-000471-4
46	1	TURBULATOR RING	S-12256
44	1	SPACER	0-000471-2
42	1	CONE	AE32-1082
40	1	GRAIN	ALCLO
38	18	PISTON	S-12276
36	1	INJECTOR	AE32-1034-1
34	1	FLANGE	AE32-1034-2
32	1	O-RING	116230-12

0-000469

30	1	DIAPHRAGM	AE32-1037-3
28	1	REPLACEMENT NOZZLE	S-12250
26	1	NOZZLE FLANGE	0-000470
24	1	O-RING	AN6230-18
22	8	BOLT HEX HEAD	STL 3/8 X 1 1/2 NC
20	1	CHAMBER	S-12254
18	16	NUT HEX	STL 3/8 X 1/2 NC
16	1	O-RING	AN6230-18
14	1	RESTRICTOR	LINEAR TAPE
12	1	CENTER SECTION	AE32-1723
10	4	SOC. HD.	STL 1/4 X 2 1/2 NF
8	1	INSERT	AE32-1037-2
6	8	BOLT HEX HEAD	STL 3/8 X 1/2 NC
4	1	NOSE SECTION	AE32-1728
2	1	FITTING	AN616-12

PROJECT NO.	10000	DATE	6-24-53
DESIGNER	W. J. JONES	CHECKED	W. J. JONES
APPROVED	W. J. JONES	DATE	6-24-53
SHORT CHAMBER TEST MOTOR ASSY			
3.75 DIA. GRAIN			
0-000469			

NOTES: 1. Remove all burrs and sharp edges.

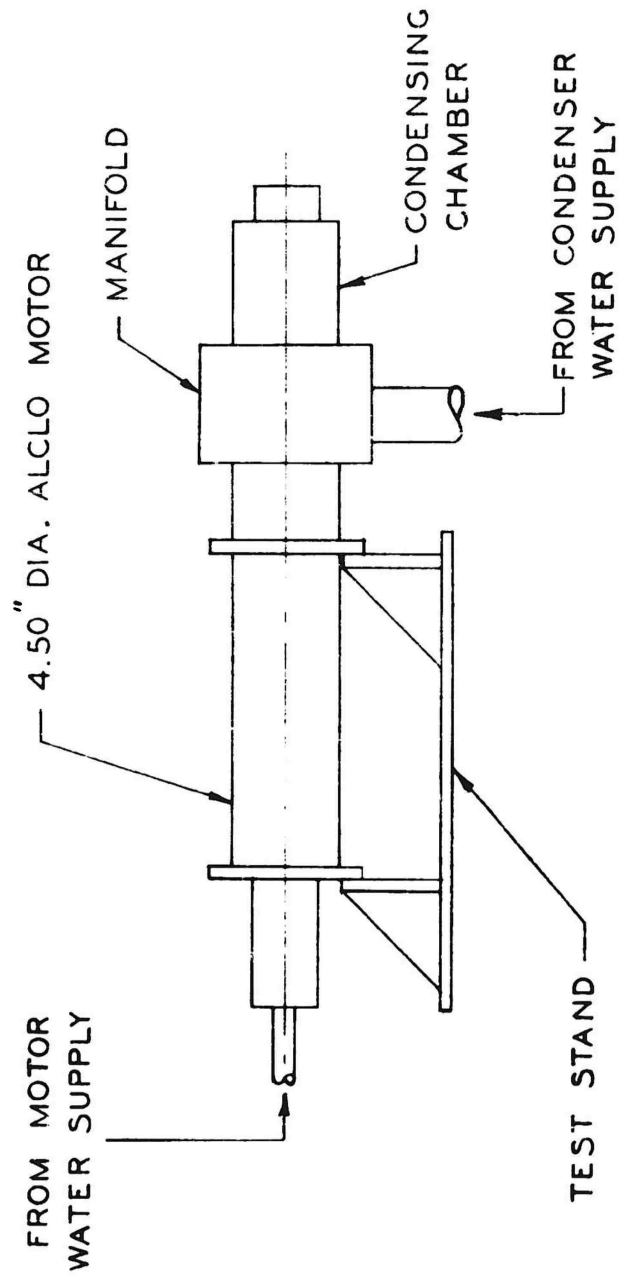
ASD FORM 886-5-50 10-54

Figure 153

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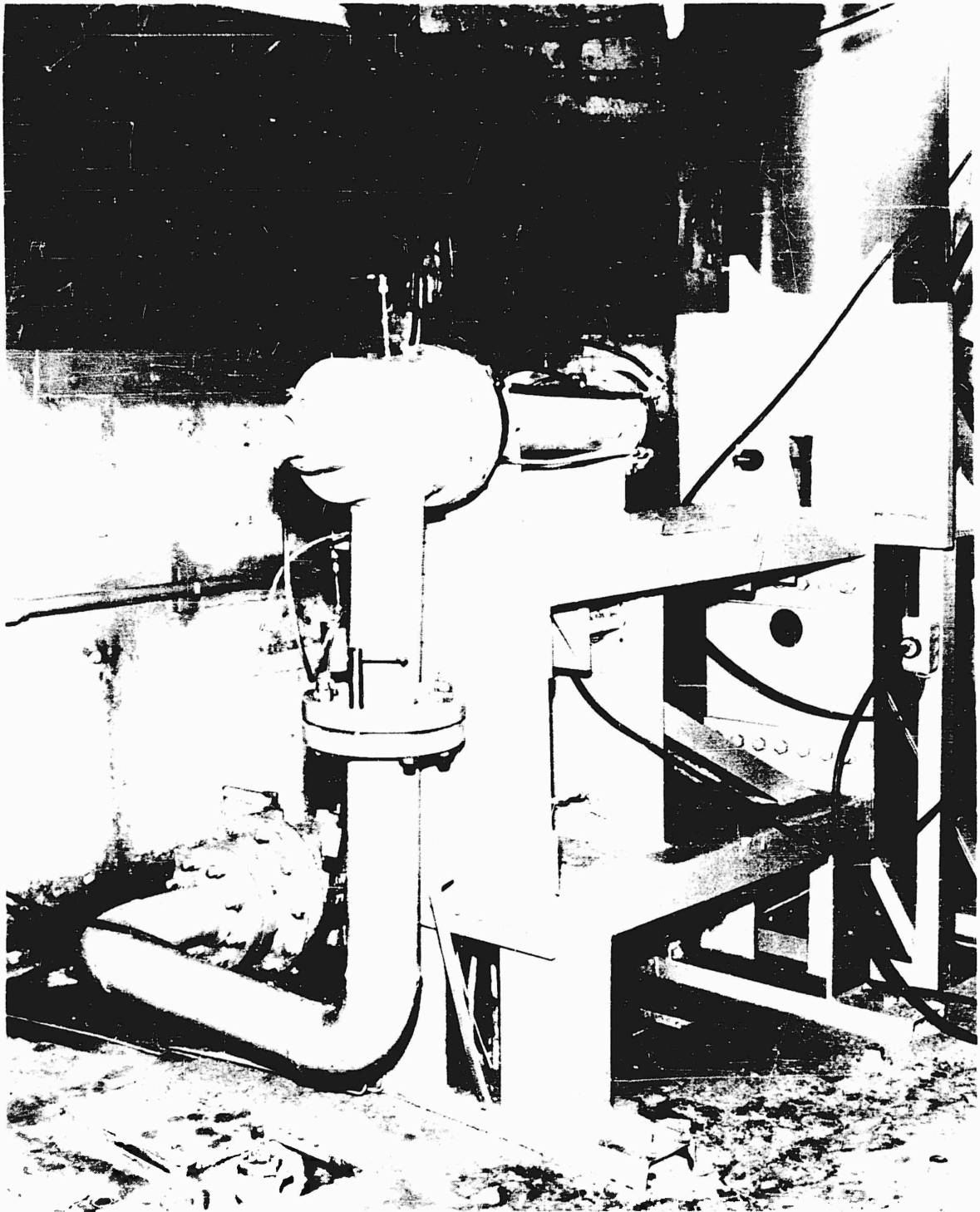
C-4148 BW/EH 12-22-52



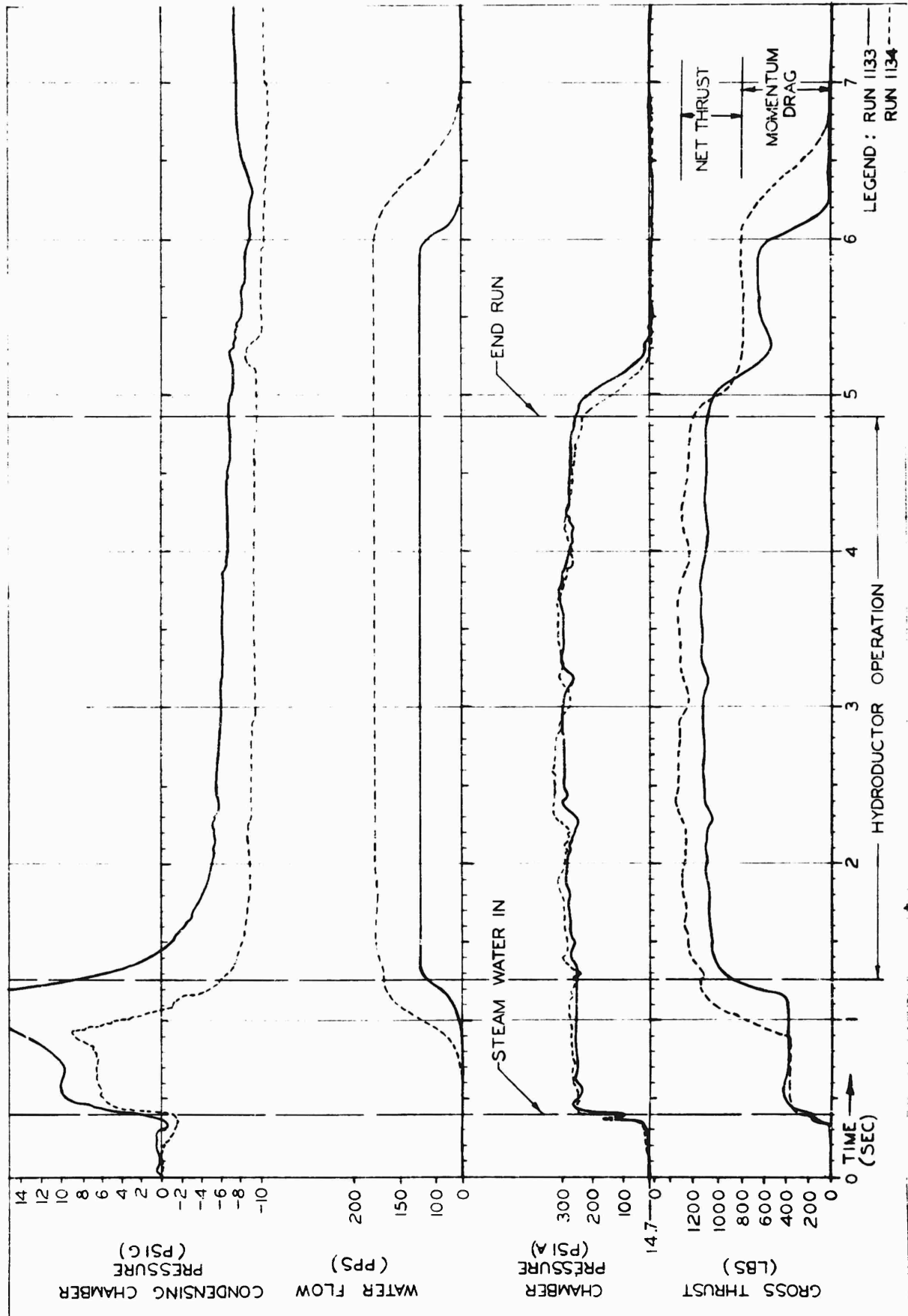
TEST INSTALLATION FOR PROTOTYPE STEAM-JET
CONDENSER

CONFIDENTIAL

Figure 154



Hydroductor Test-Pit Setup

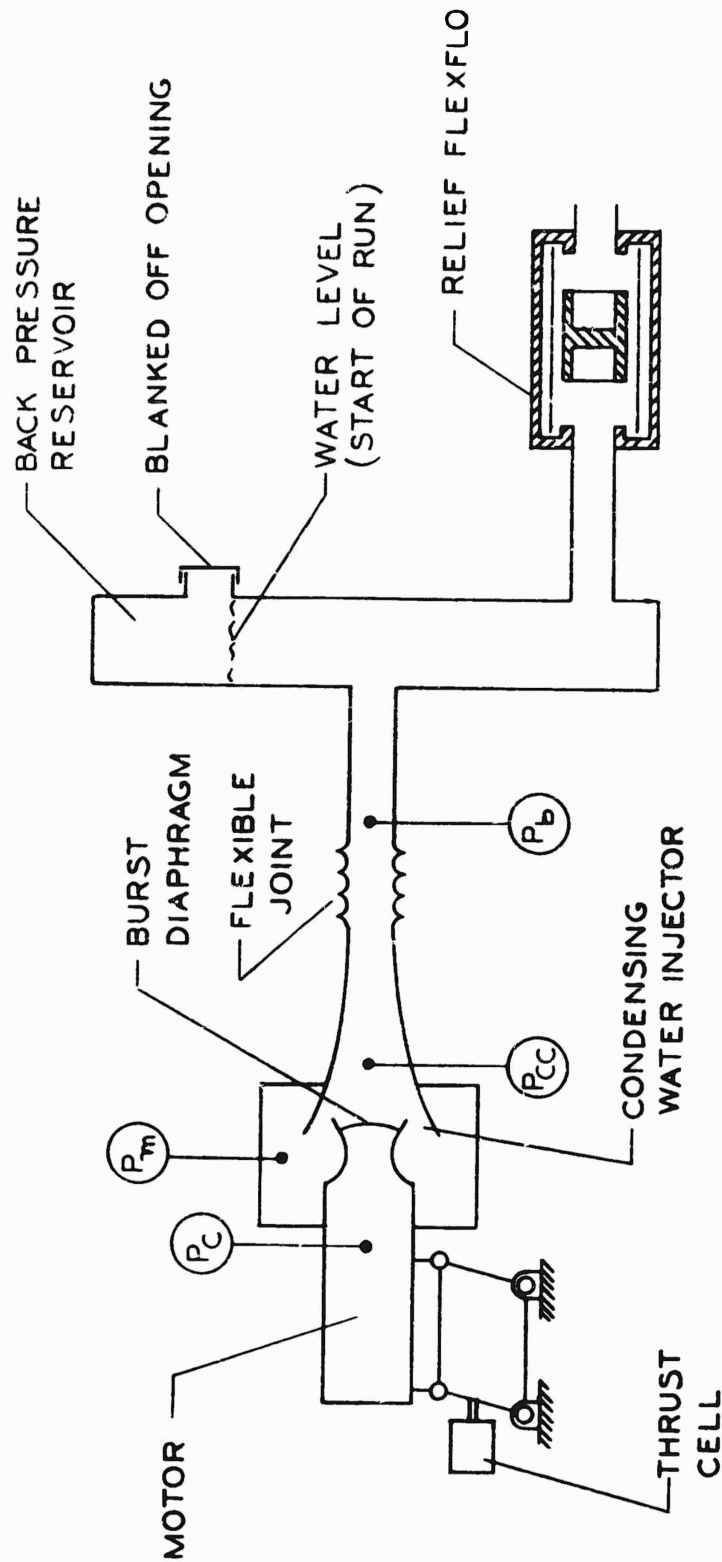


Hydroductor Runs No. 1133 and 1134

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Report No. 1106

C-4315 12-21-54 R.S. eh

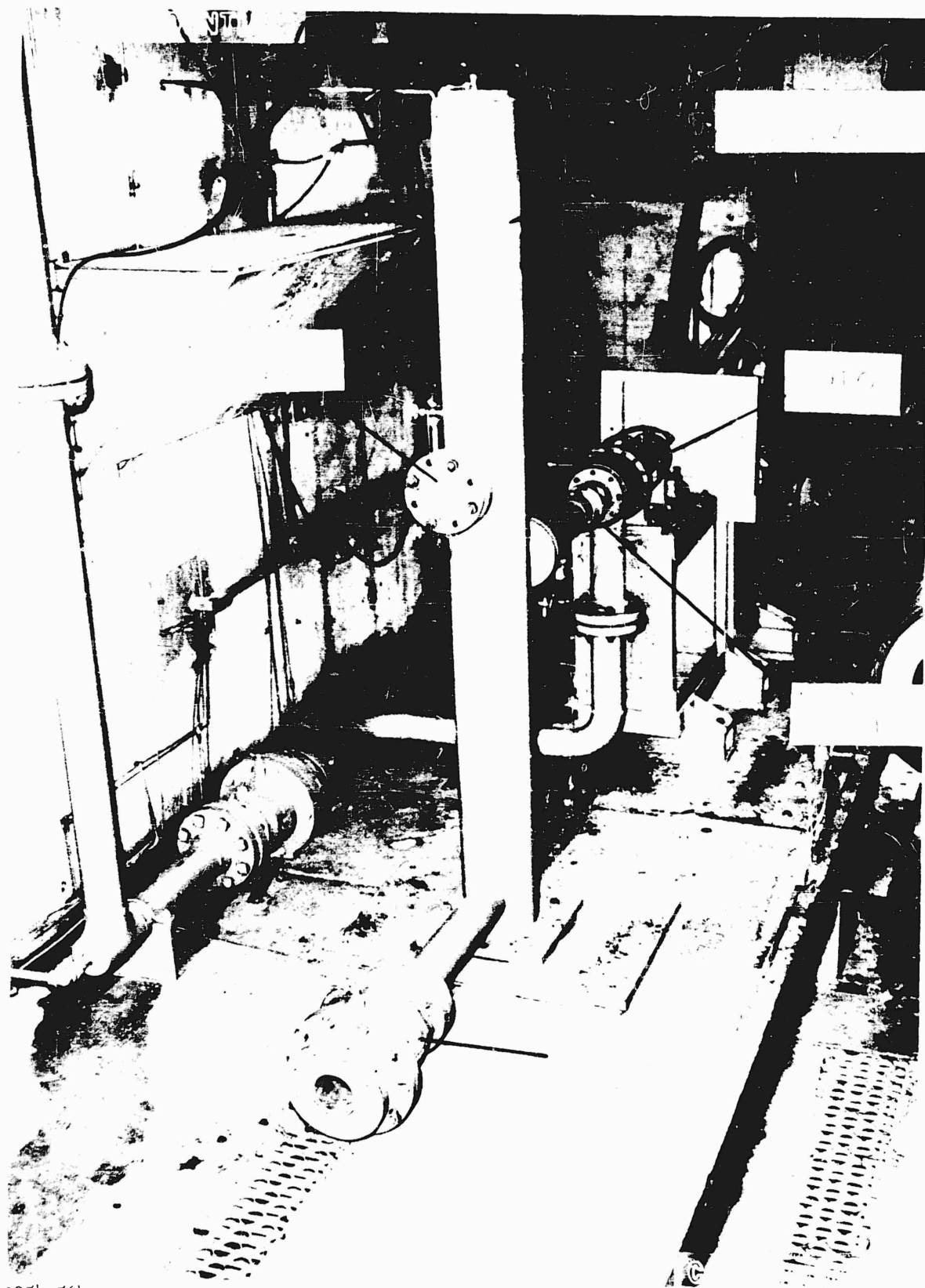


P_c - COMBUSTION CHAMBER PRESSURE
 P_{cc} - CONDENSING CHAMBER PRESSURE
 P_m - MANIFOLD PRESSURE
 (TOTAL HEAD OF CONDENSING WATER)
 P_b - BACK PRESSURE ON SYSTEM

SCHEMATIC - HYDRODUCTOR BACK-PRESSURE FACILITY

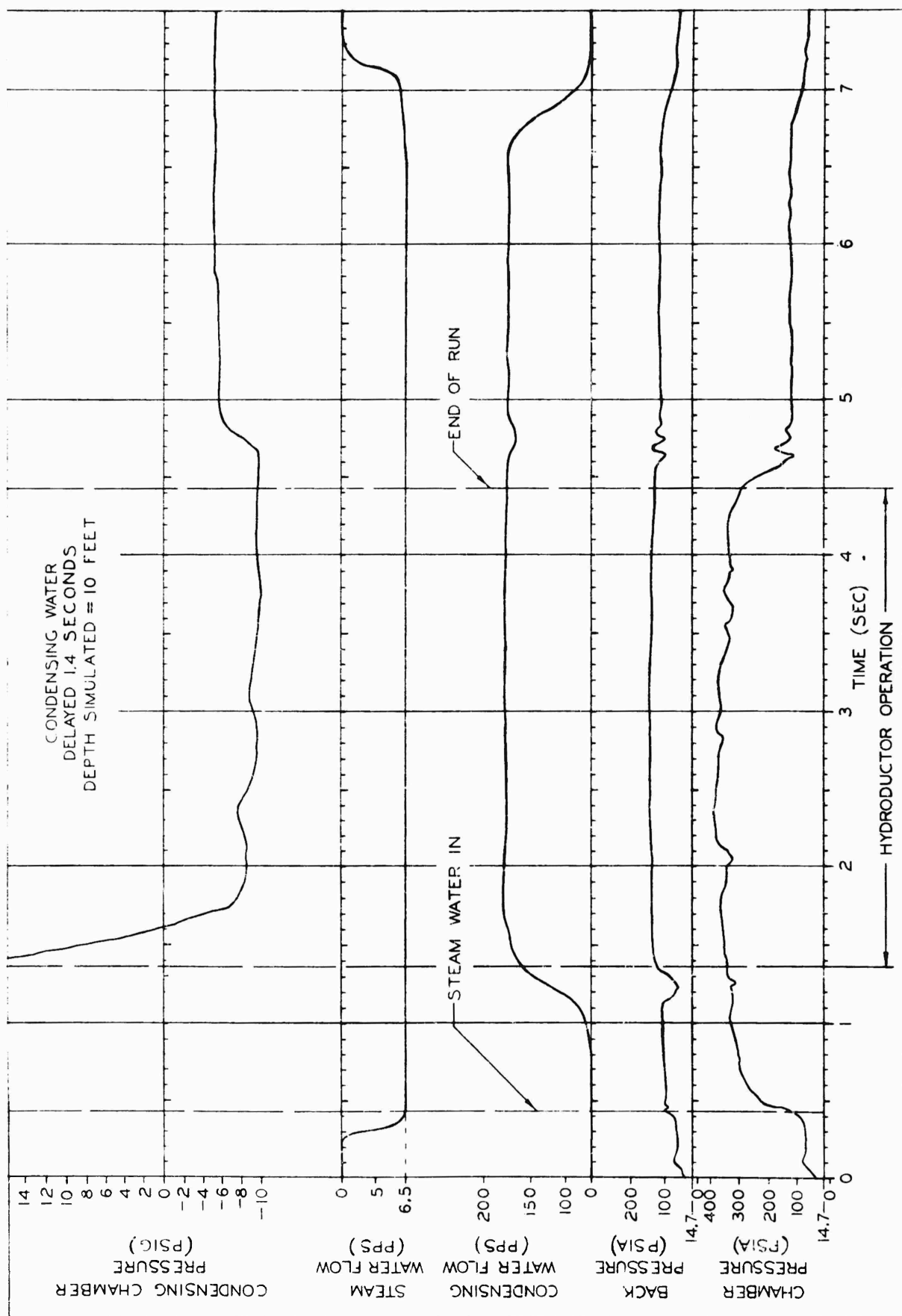
CONFIDENTIAL

Figure 158

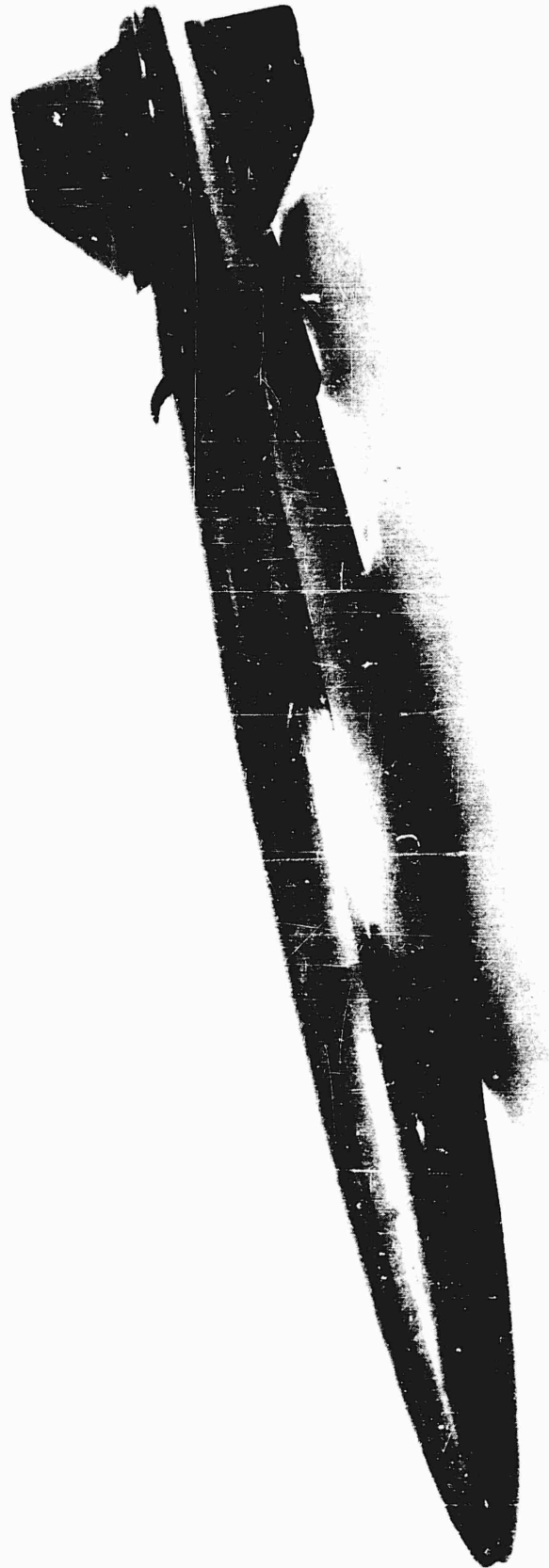


125h-56h

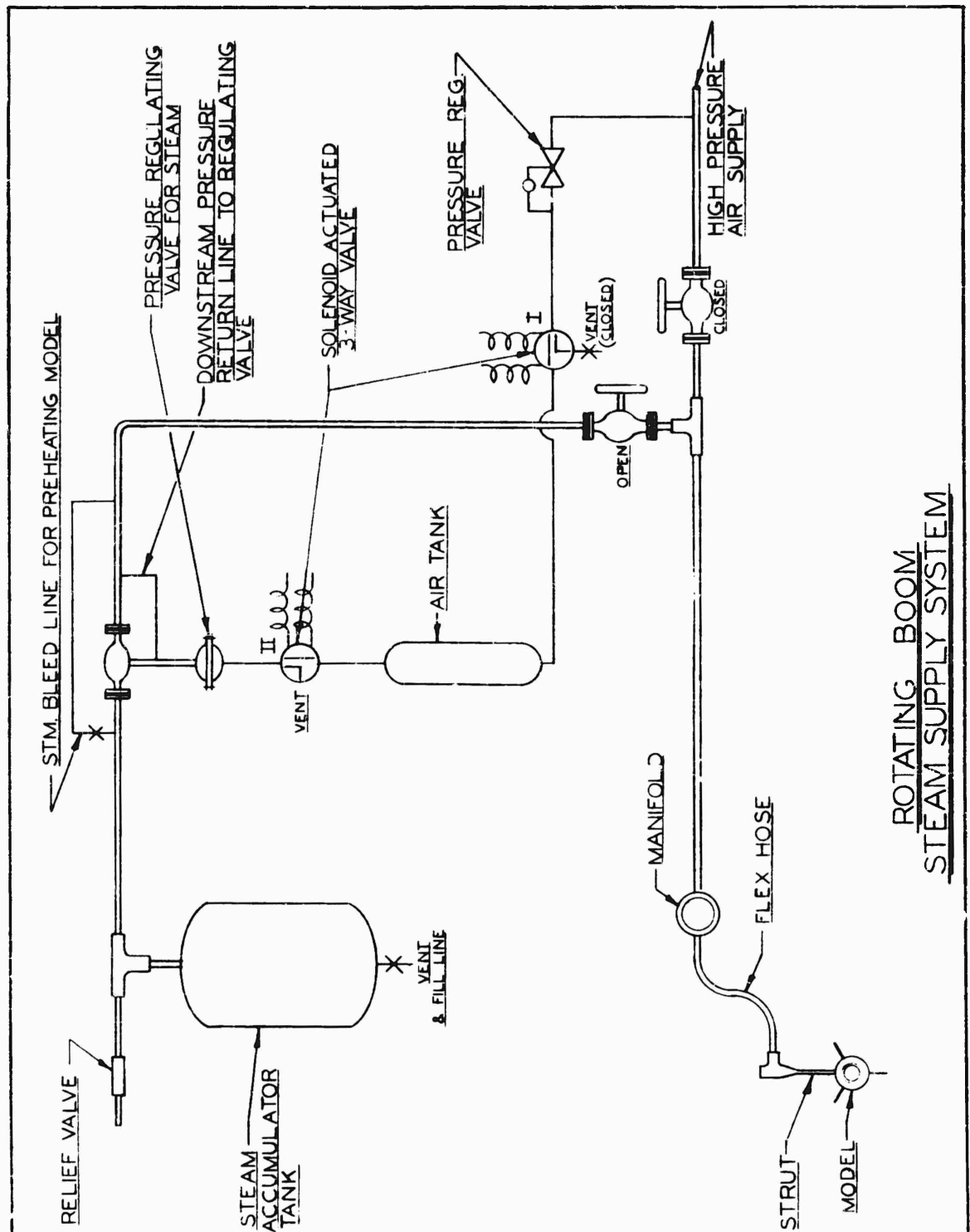
Hydroductor Back-Pressure Test Facility



Hydroductor Run No. 1135



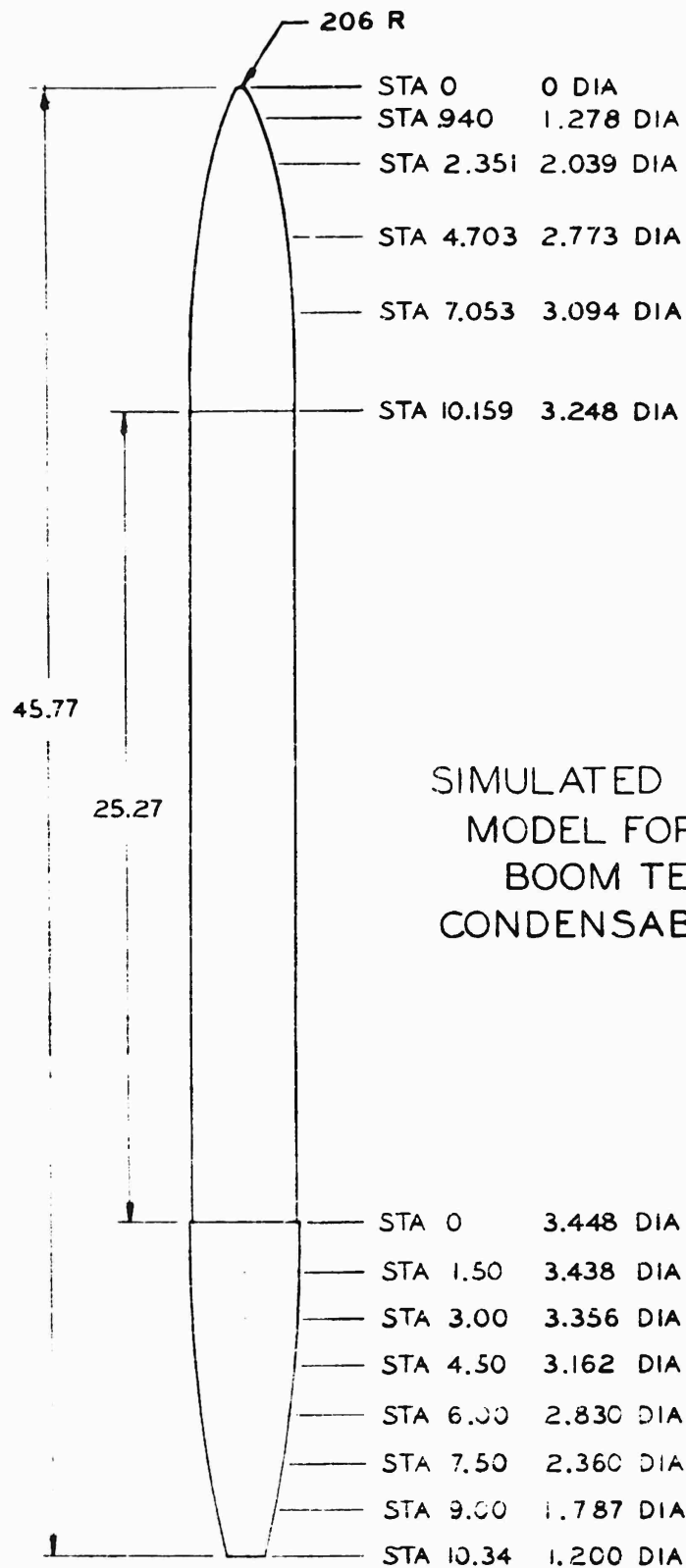
Hydroductor No. 1



C-4236

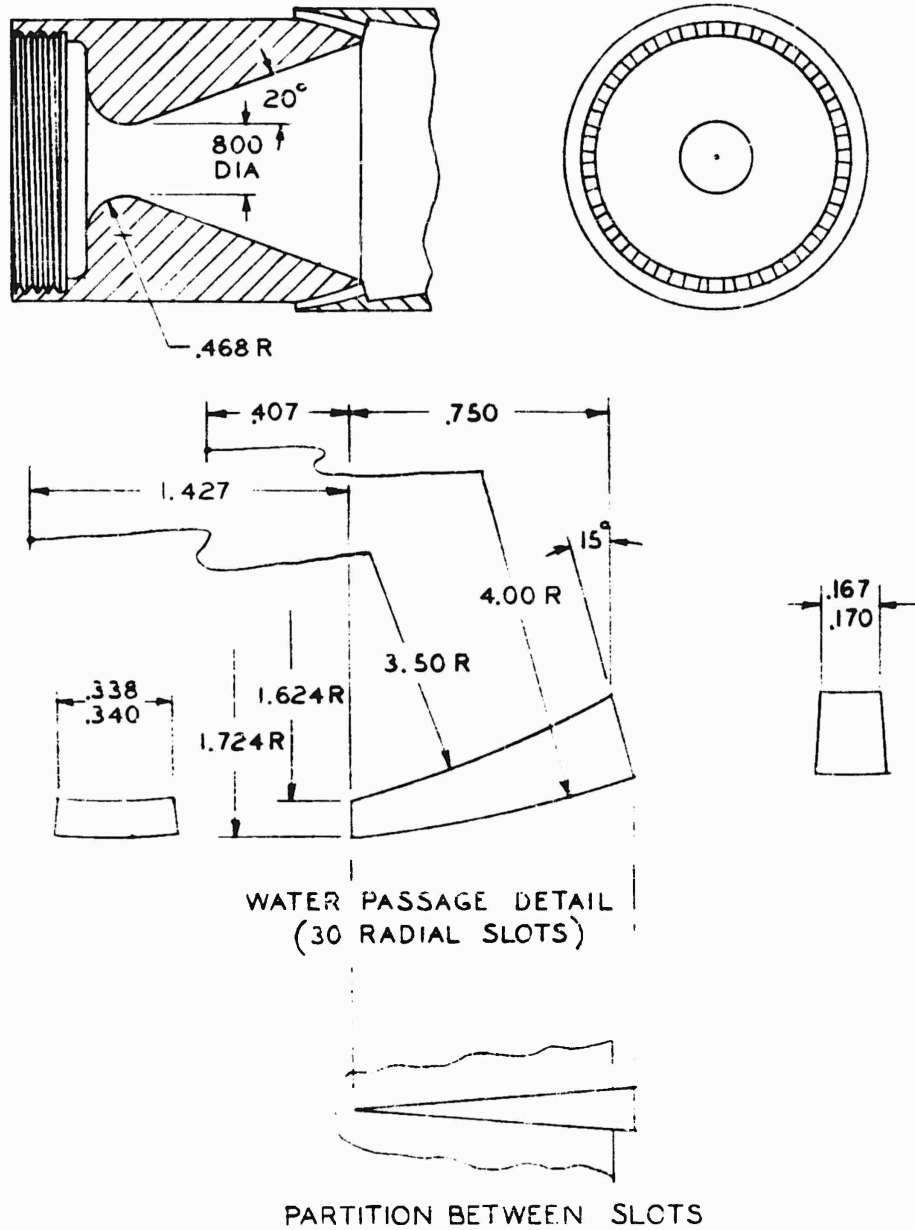
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Report No. 1106



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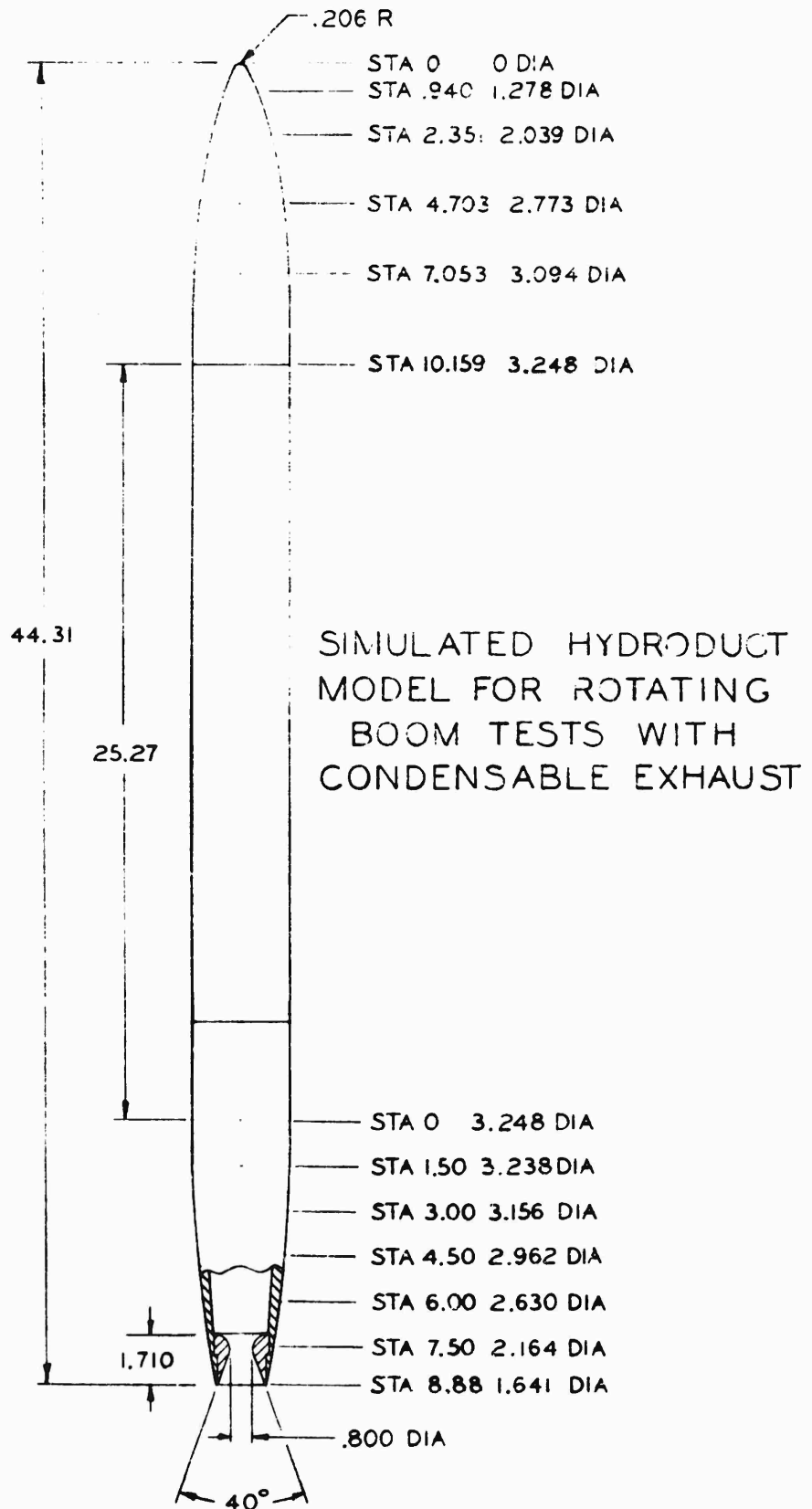
Figure 163



HYDRODUCTOR STEAM NOZZLE
AND SCOOP PASSAGE DETAILS

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Report No. 1106



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Figure 165

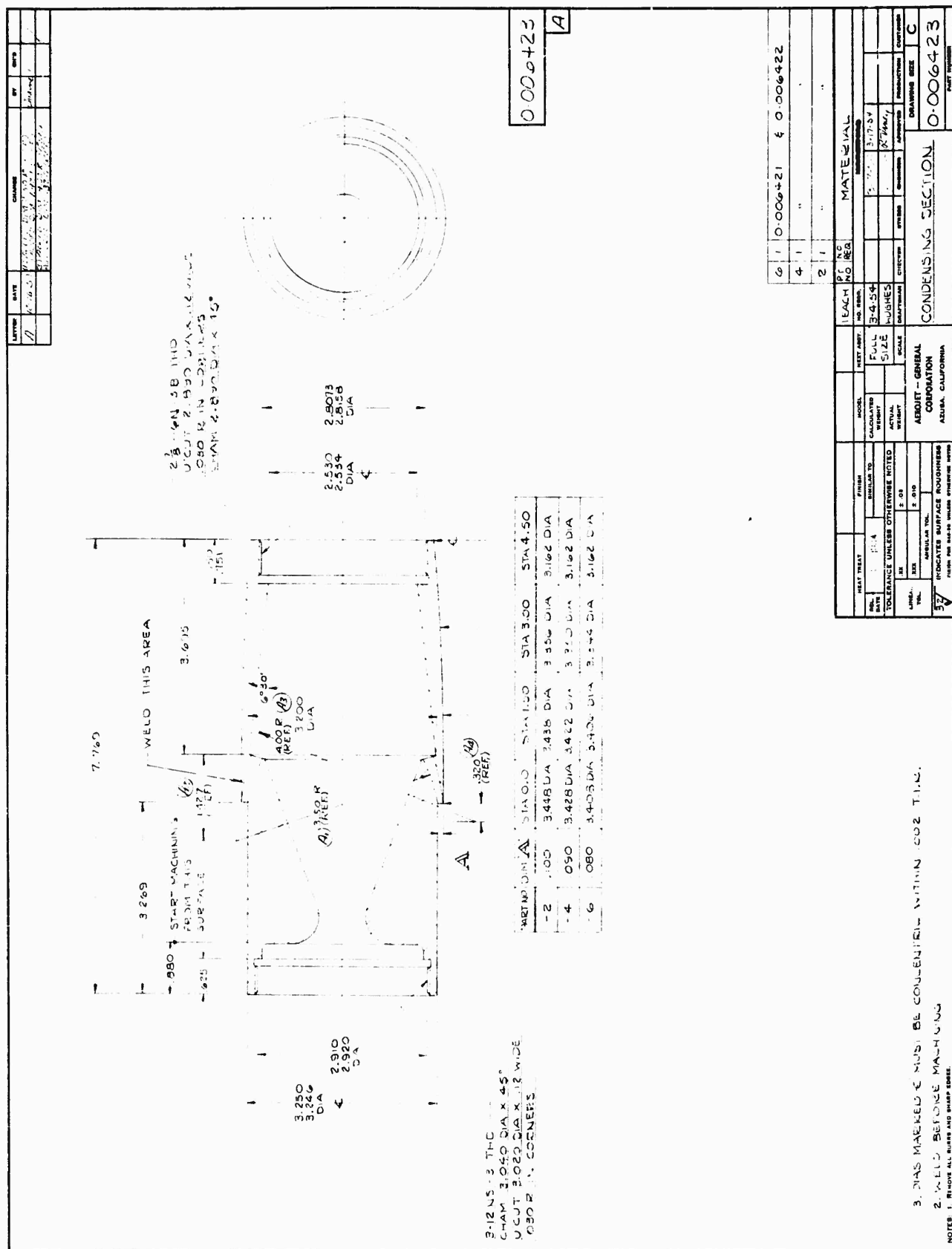
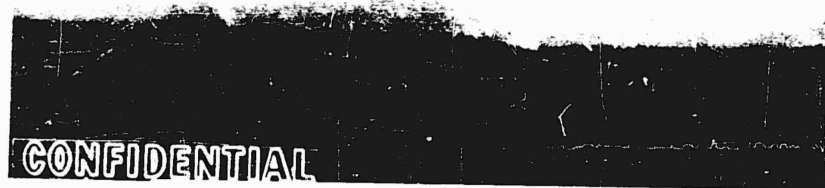
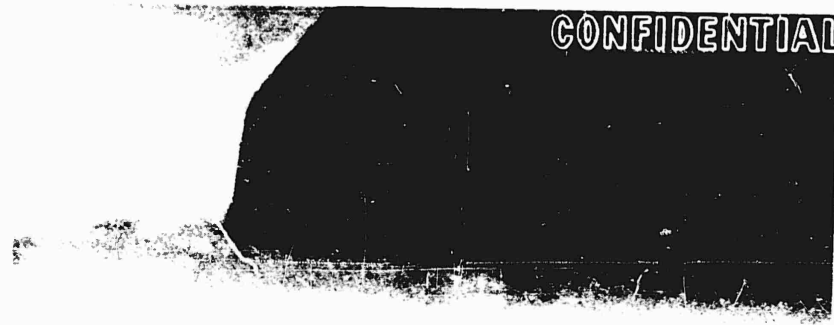




Fig. 167 Constant-Area Scoop, Microflash



Fig. 168 Improved Constant-Area Scoop, Microflash



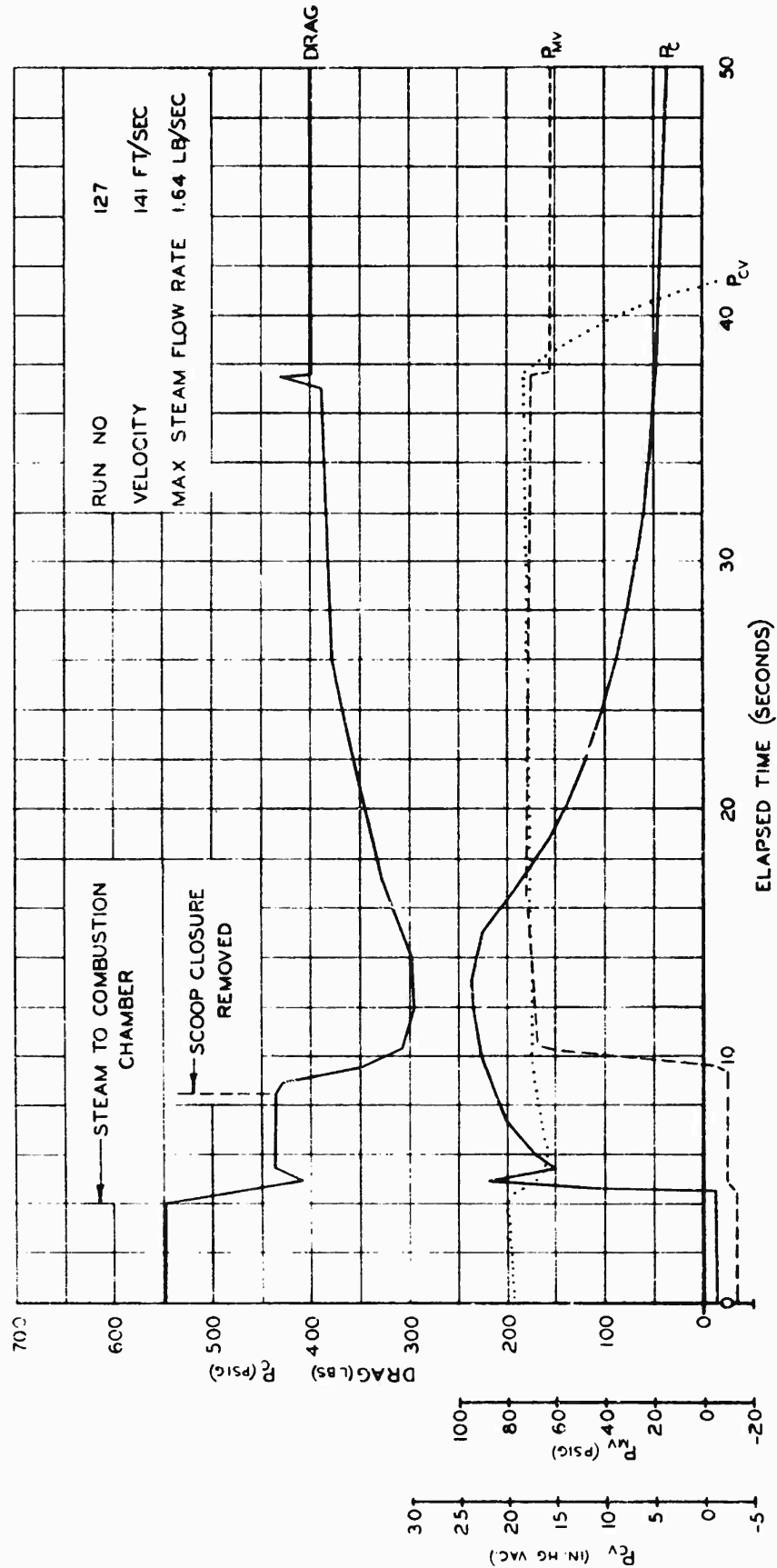
10SL-925

Fig. 169 10%-Increasing-Area Scoop, Microflash



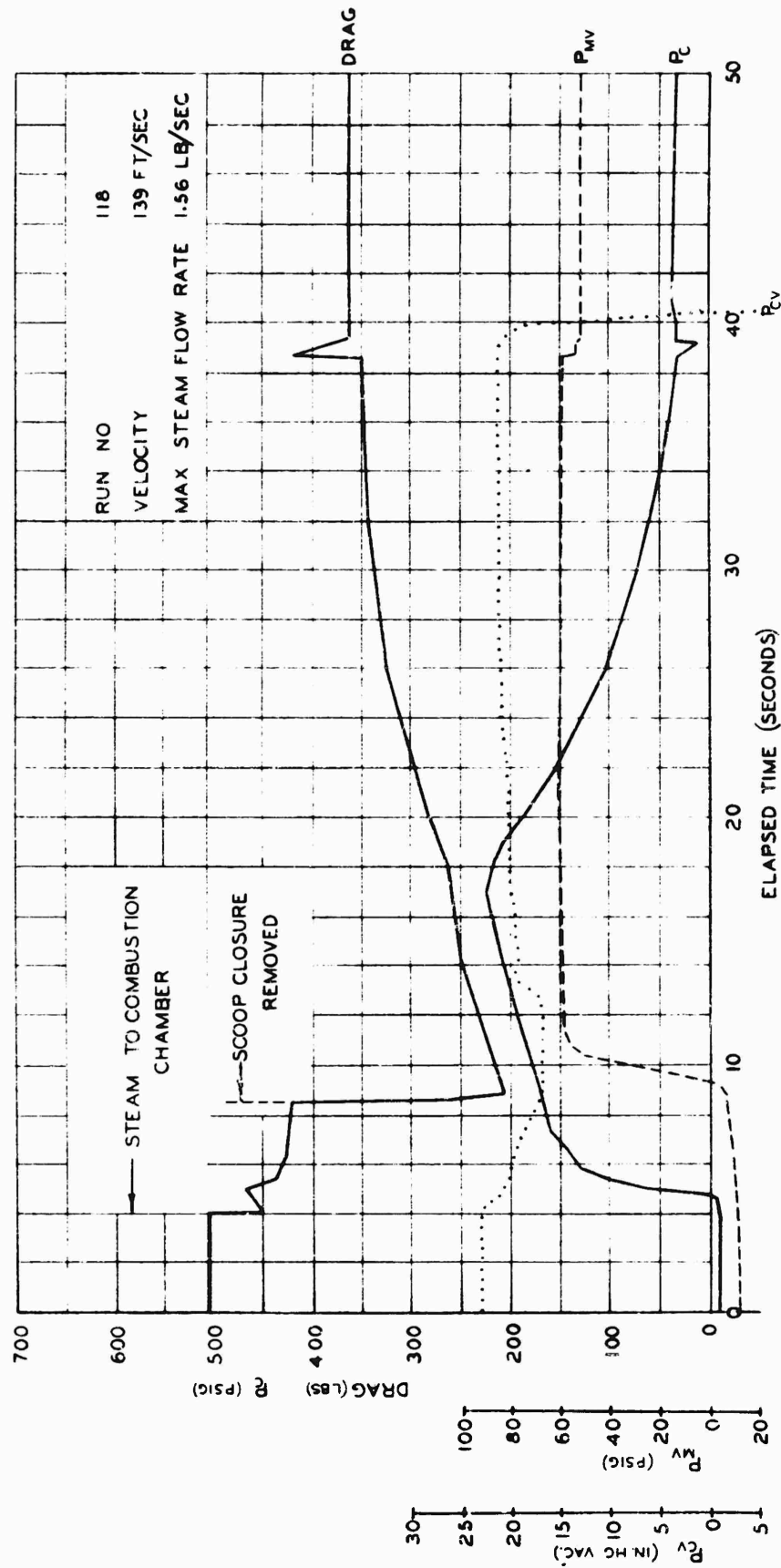
10SL-490

Fig. 170 20%-Increasing-Area Scoop, Microflash

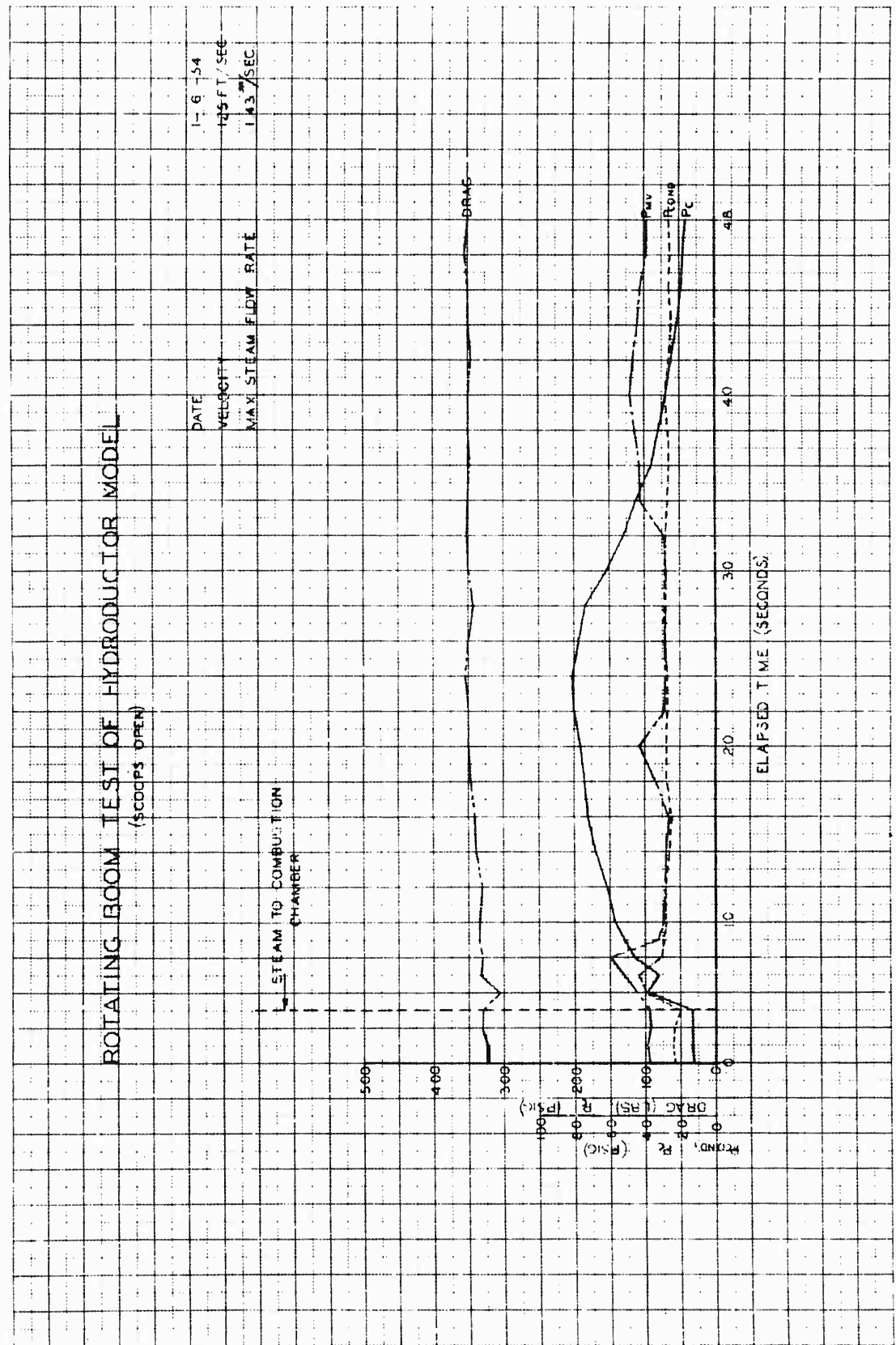


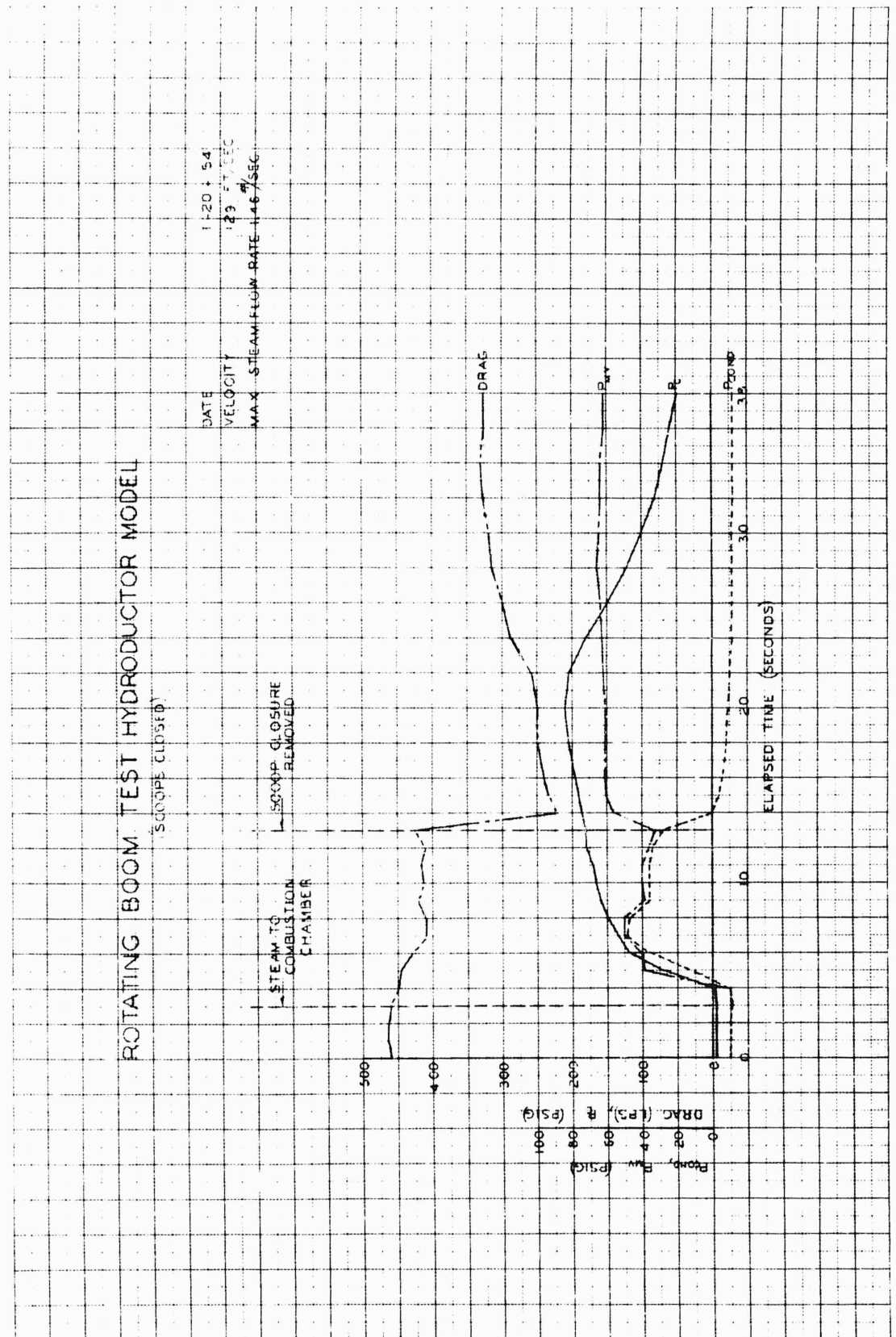
ROTATING BOOM TEST OF HYDRODUCTOR MODEL
SCOOP HEIGHT = 0.090 INCH
AREA RATIO = 0.7

Figure 171

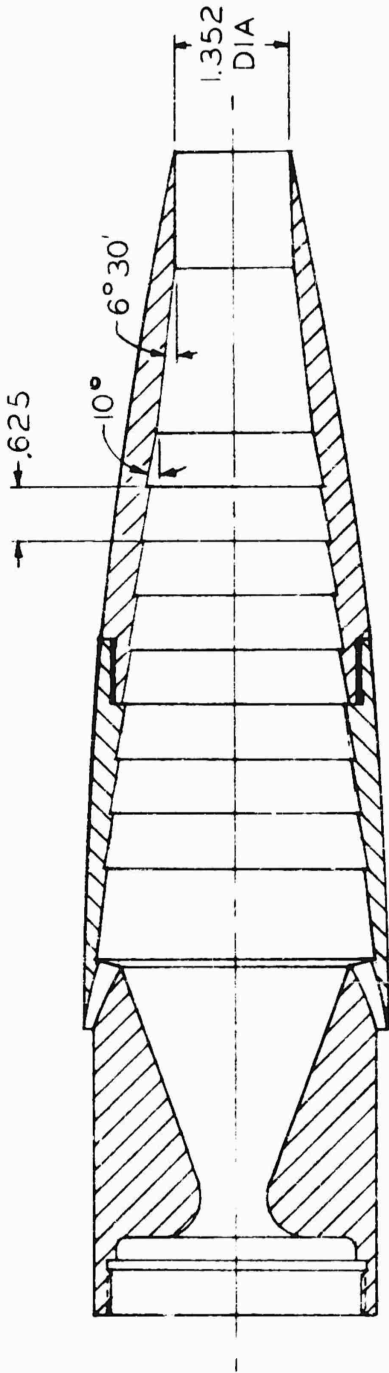


ROTATING BOOM TEST OF HYDRODUCTOR MODEL
SCOOP HEIGHT = 0.100 INCH AREA RATIO = 0.7
(FULLY STEPPED AFTERBODY)





C-4313 12-7-54 WSD

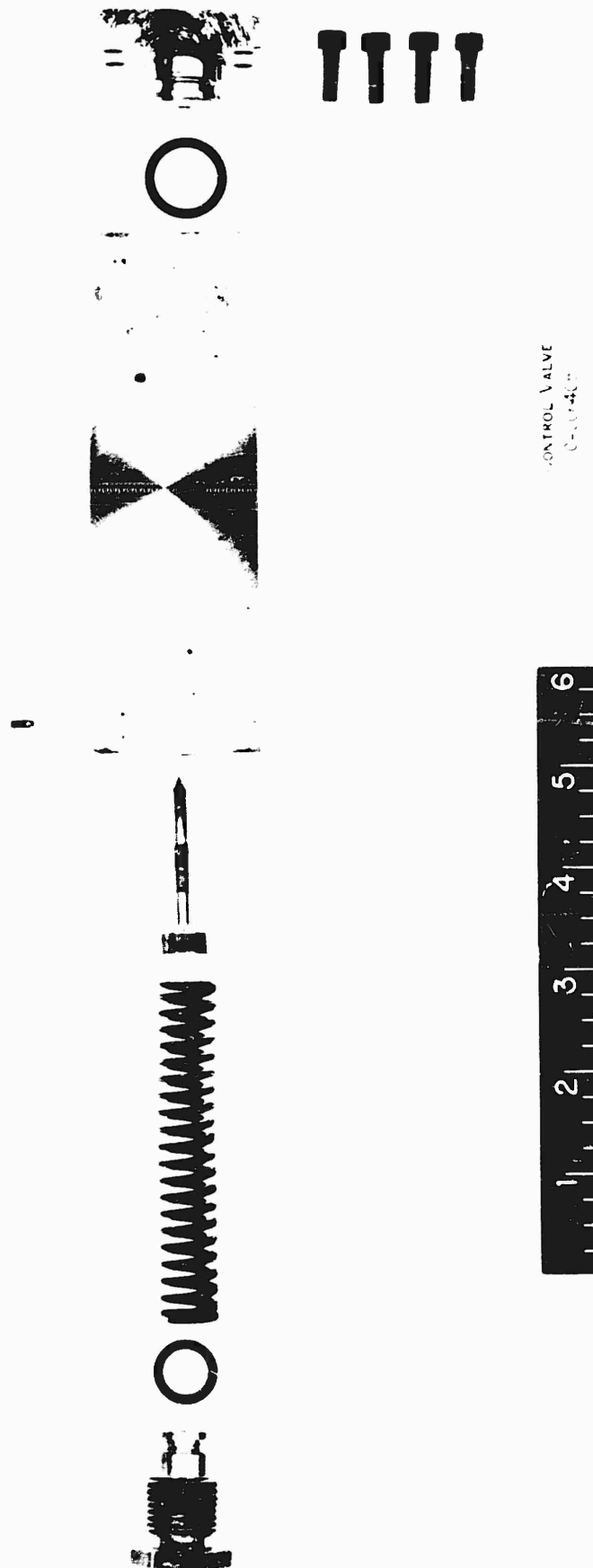


STEPPED CONDENSING SECTION

Figure 175

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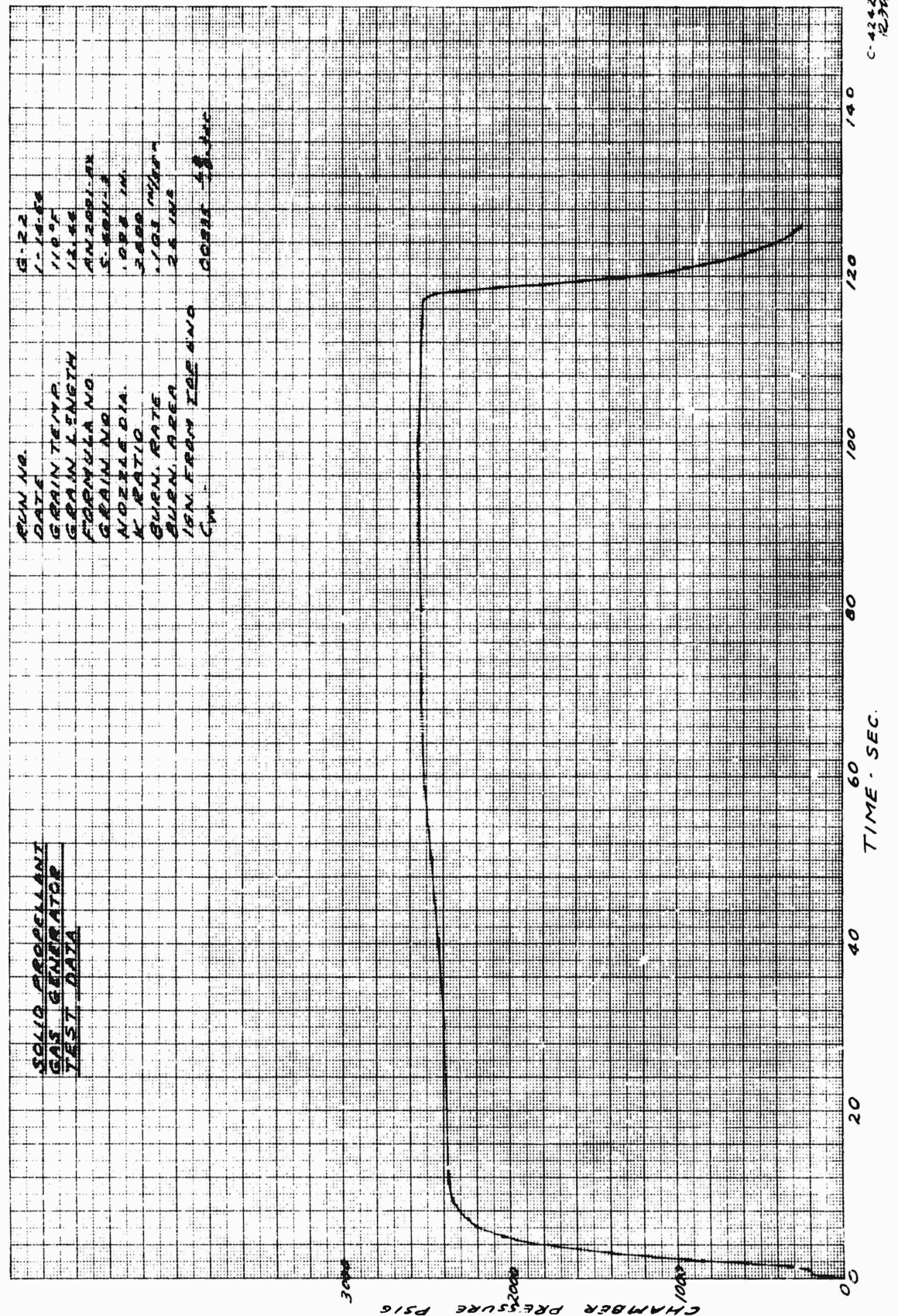


654-625

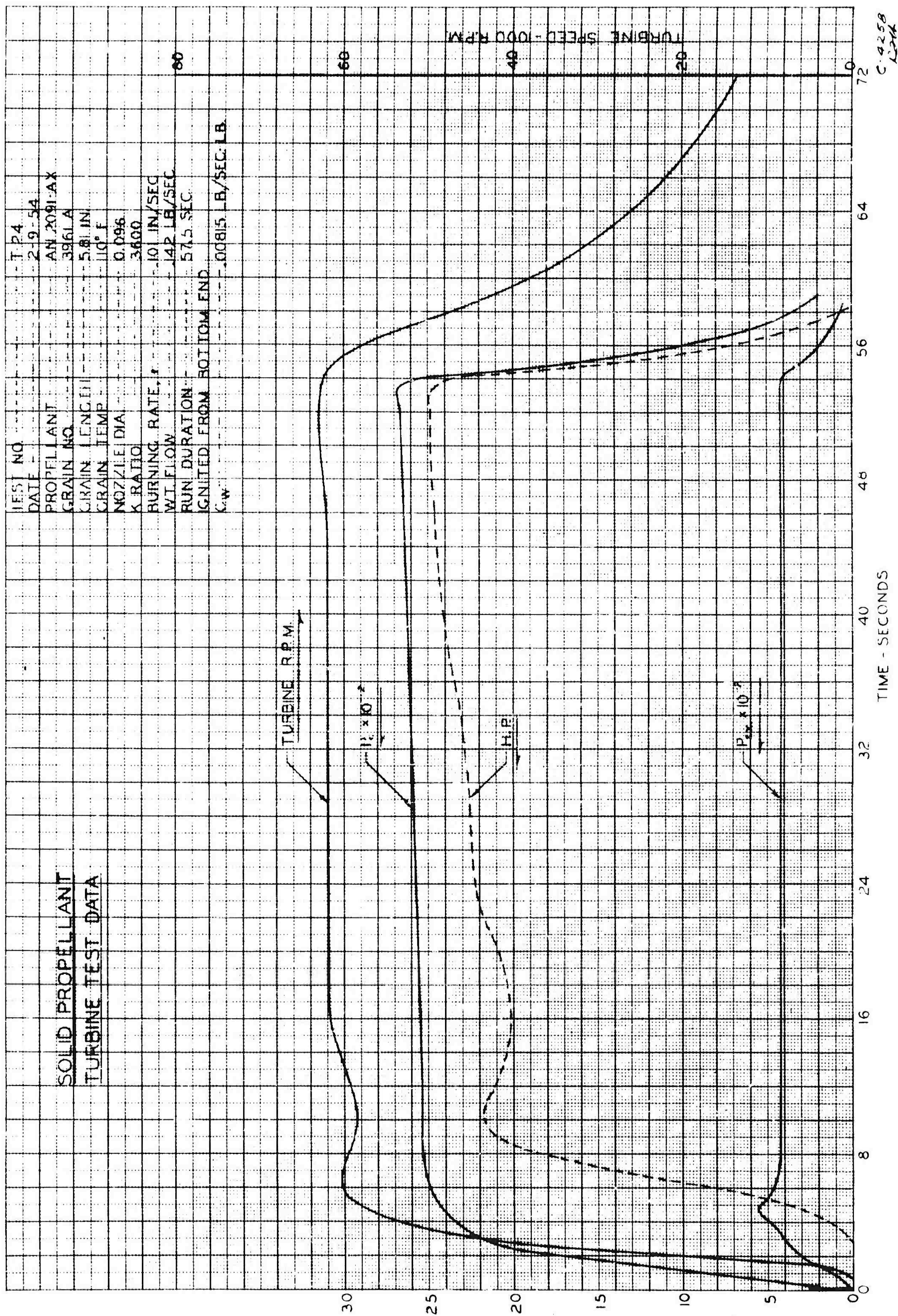
Turbine Speed Controller Components

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Figure 176



Pressure-Time Data for 2-Minute Test



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SCHEMATIC DIAGRAM
SPEED CONTROL
SYSTEM

C - 4397 8-12-55 CLG

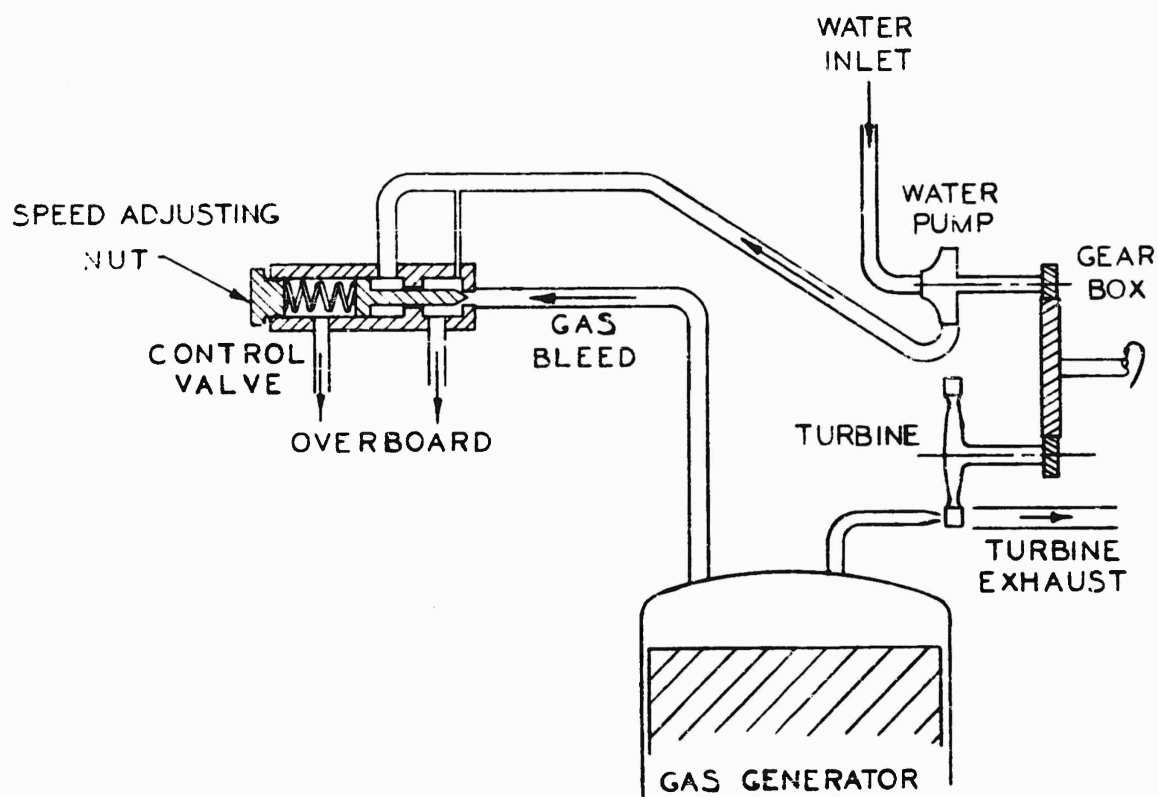
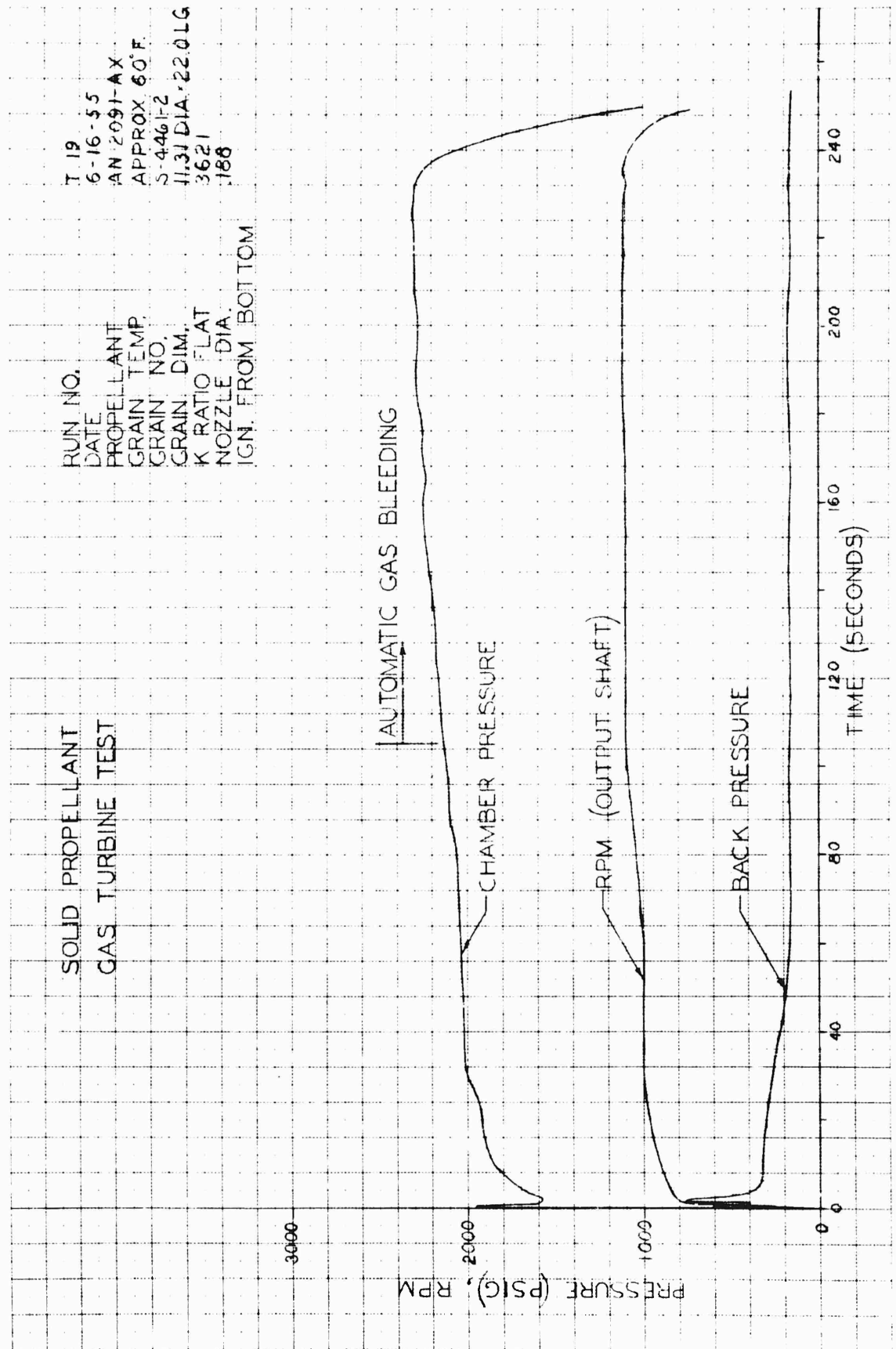


Figure 179

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Figure 180

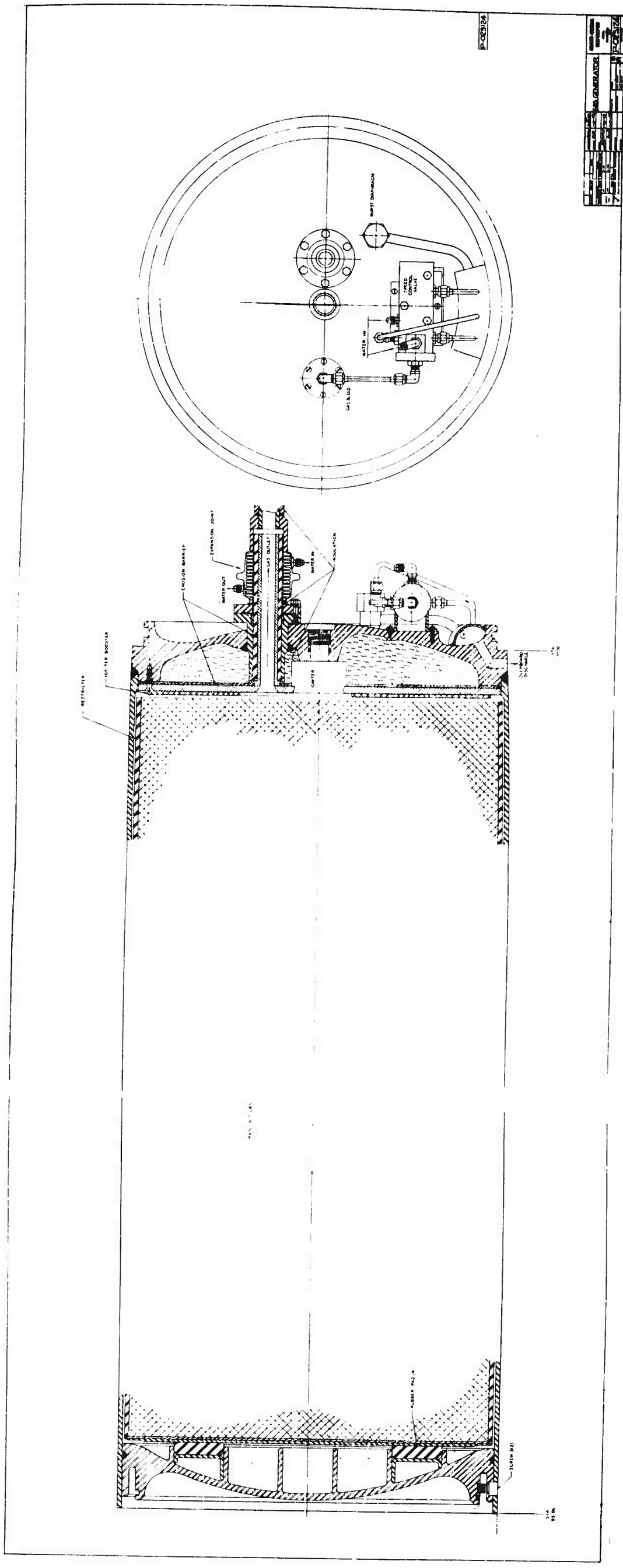
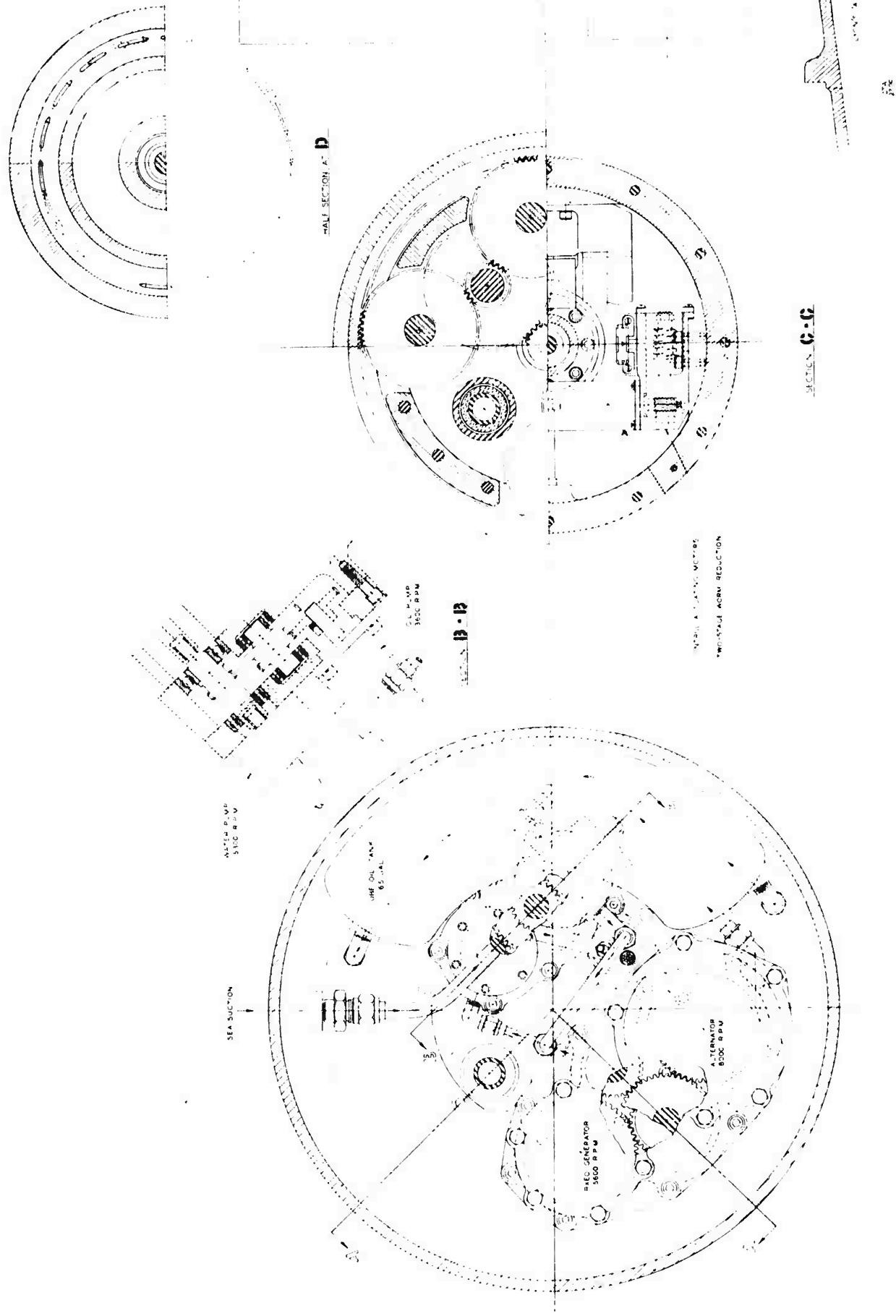


Figure 181

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11



2

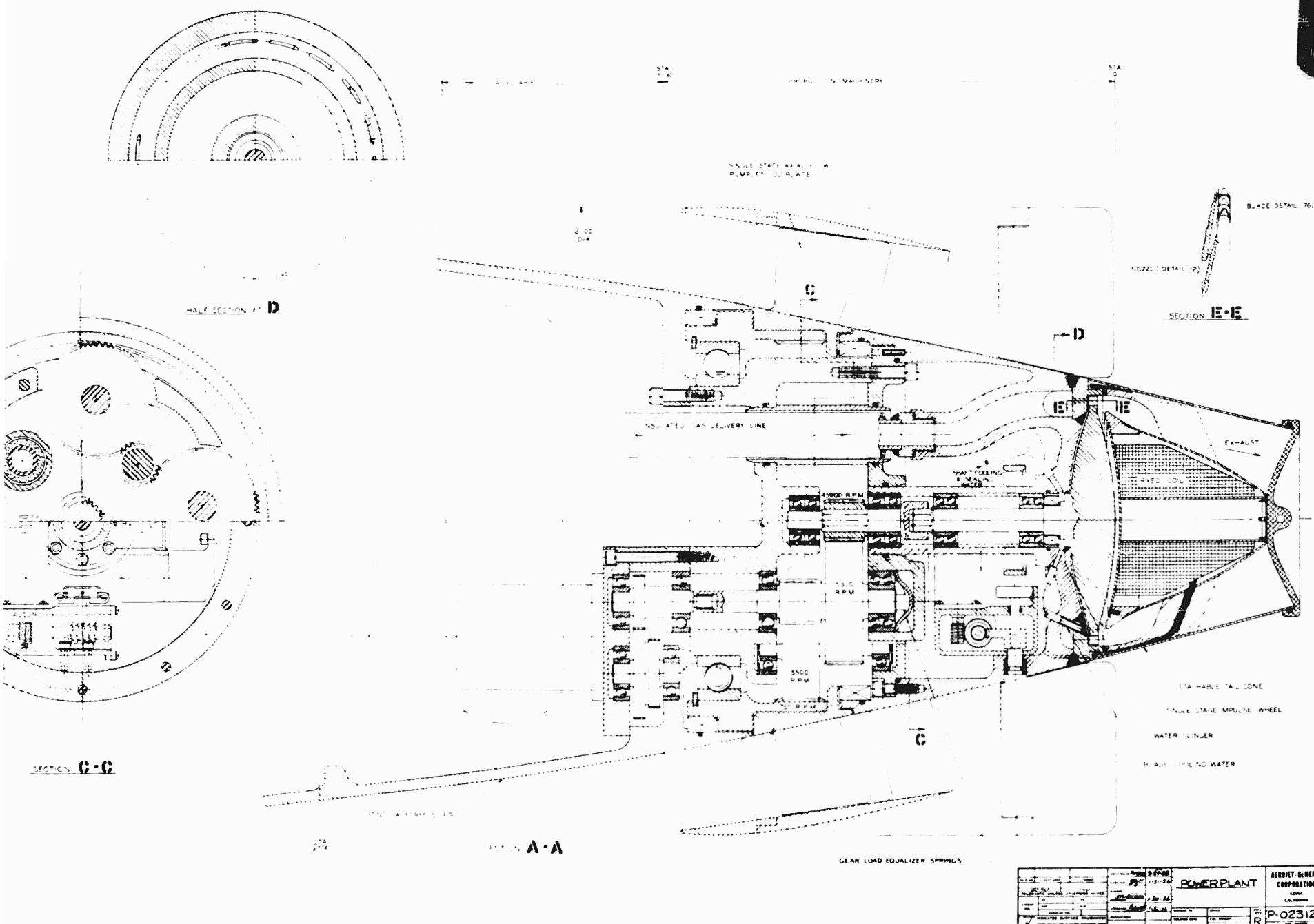
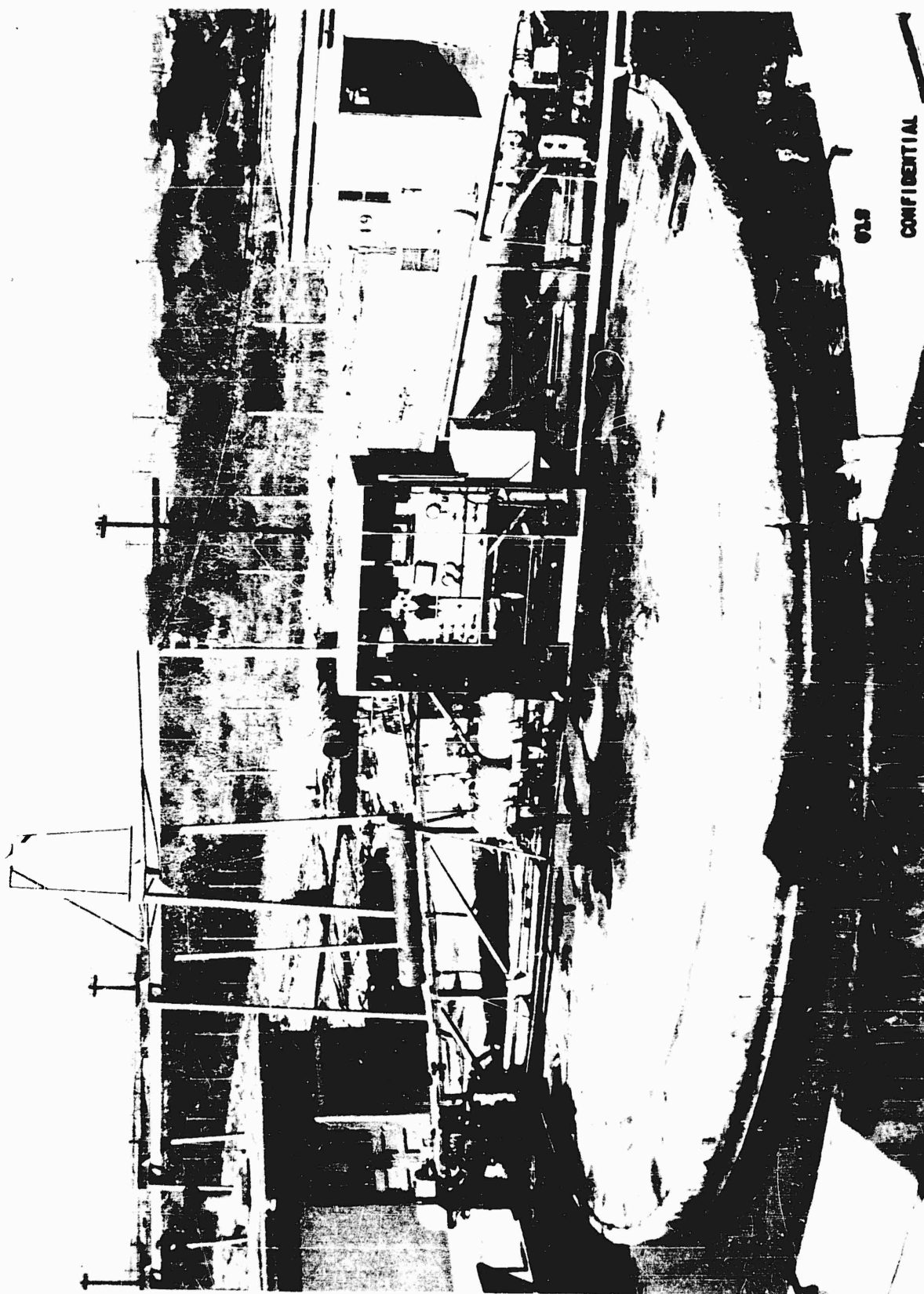


Figure 182

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Report No. 1106



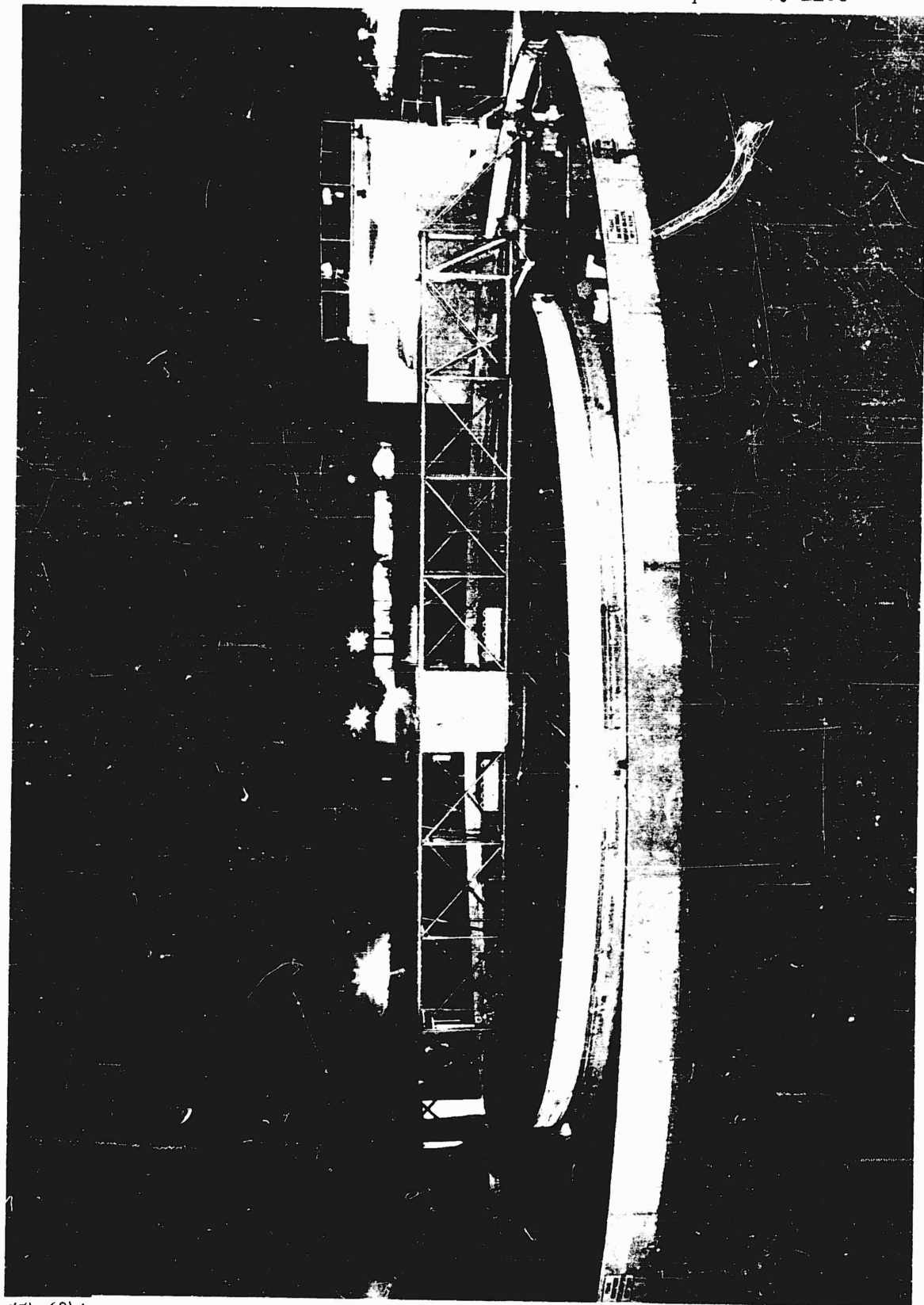
Forty Foot Rotating Boom and Ring Channel

UNCLASSIFIED

Figure 183

UNCLASSIFIED

Report No. 1106



Eighty Foot Rotating Beam and Ring Channel Facility

554-684A

Figure 184

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Report No. 1106



Underwater Missile Body with Stepped Profile

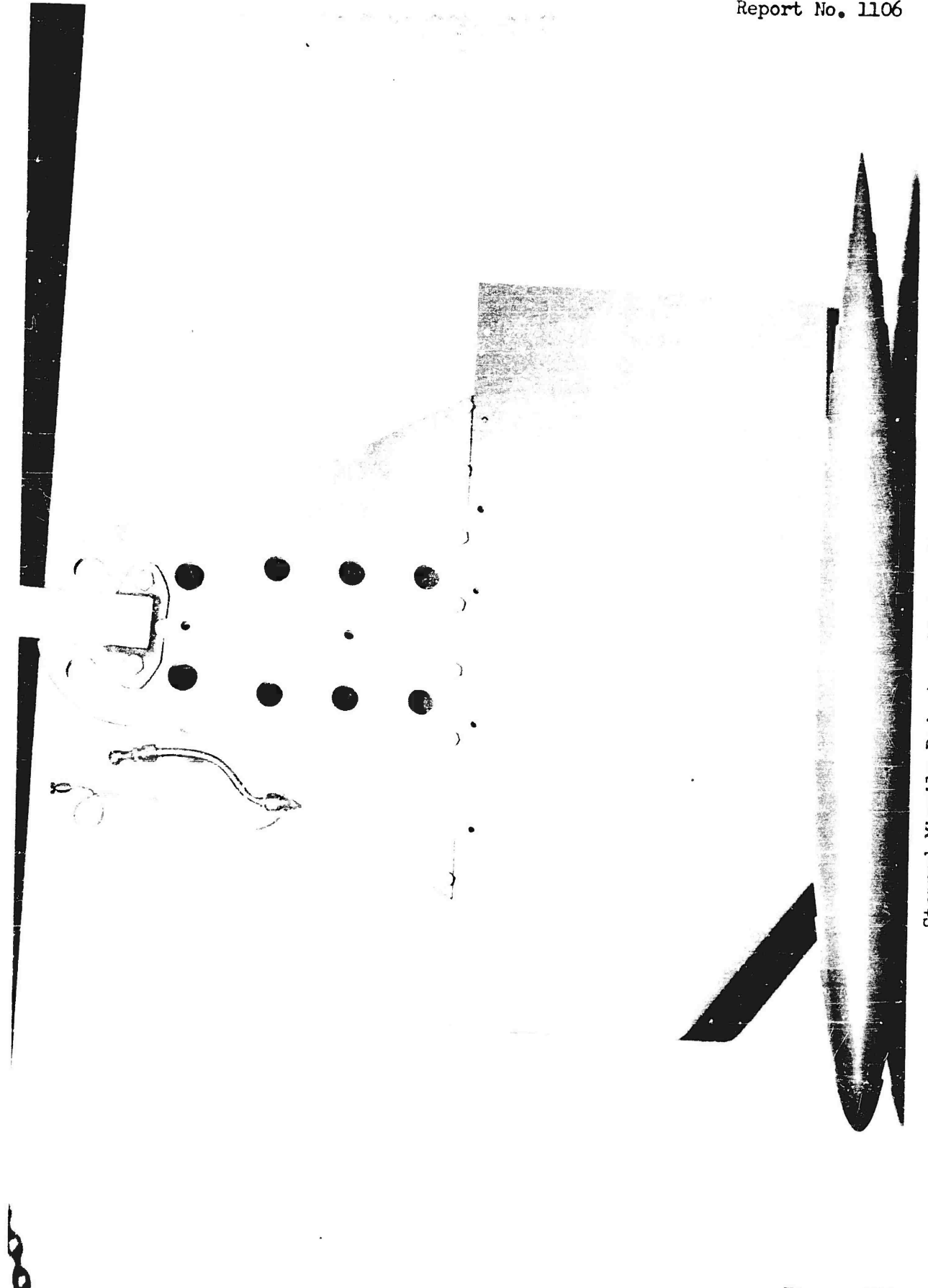
R0750-11

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Figure 185

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Report No. 1106



Stepped Missile Body Assembled on Mounting Strut

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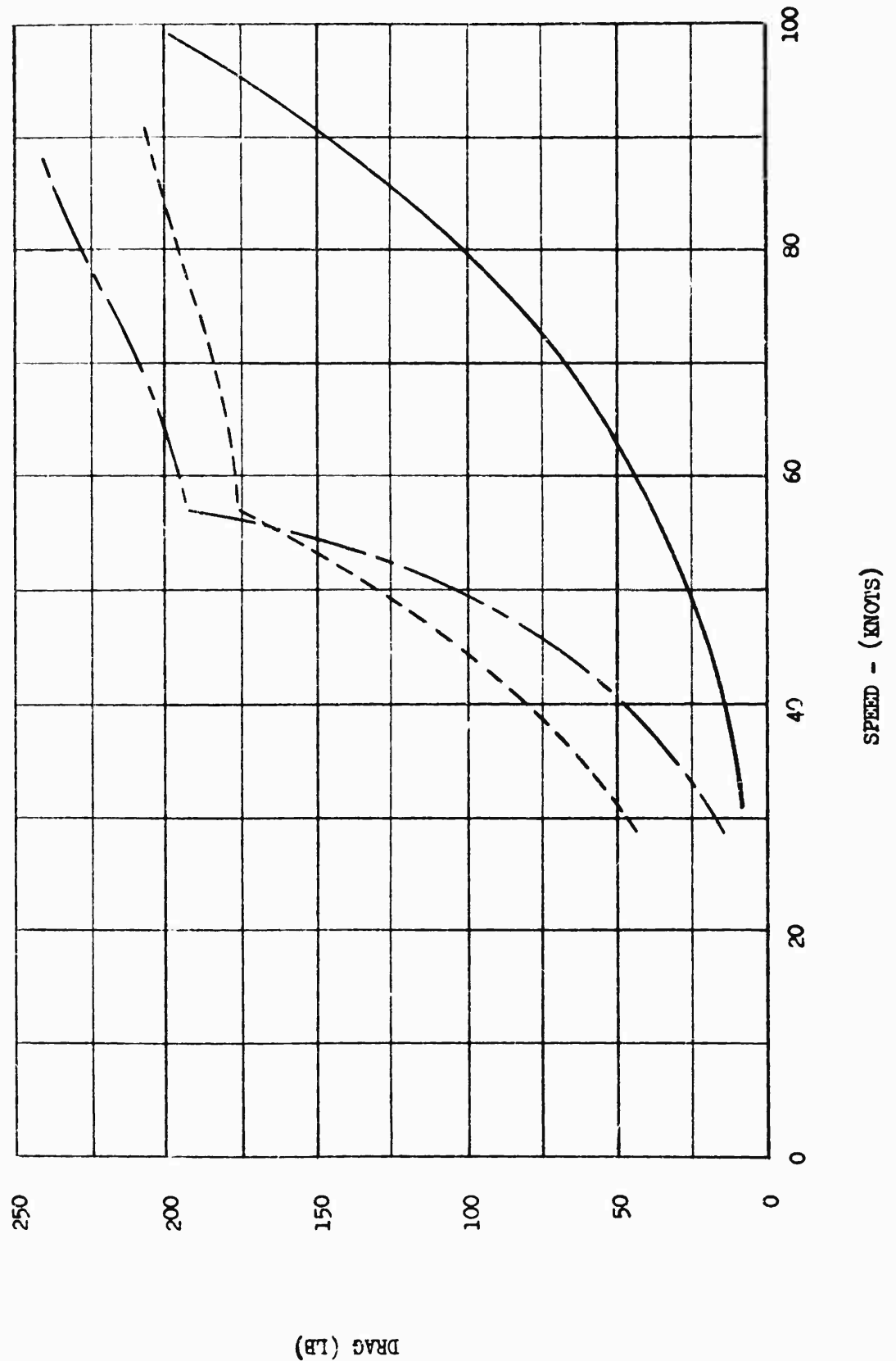
Figure 186

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Report No. 1106

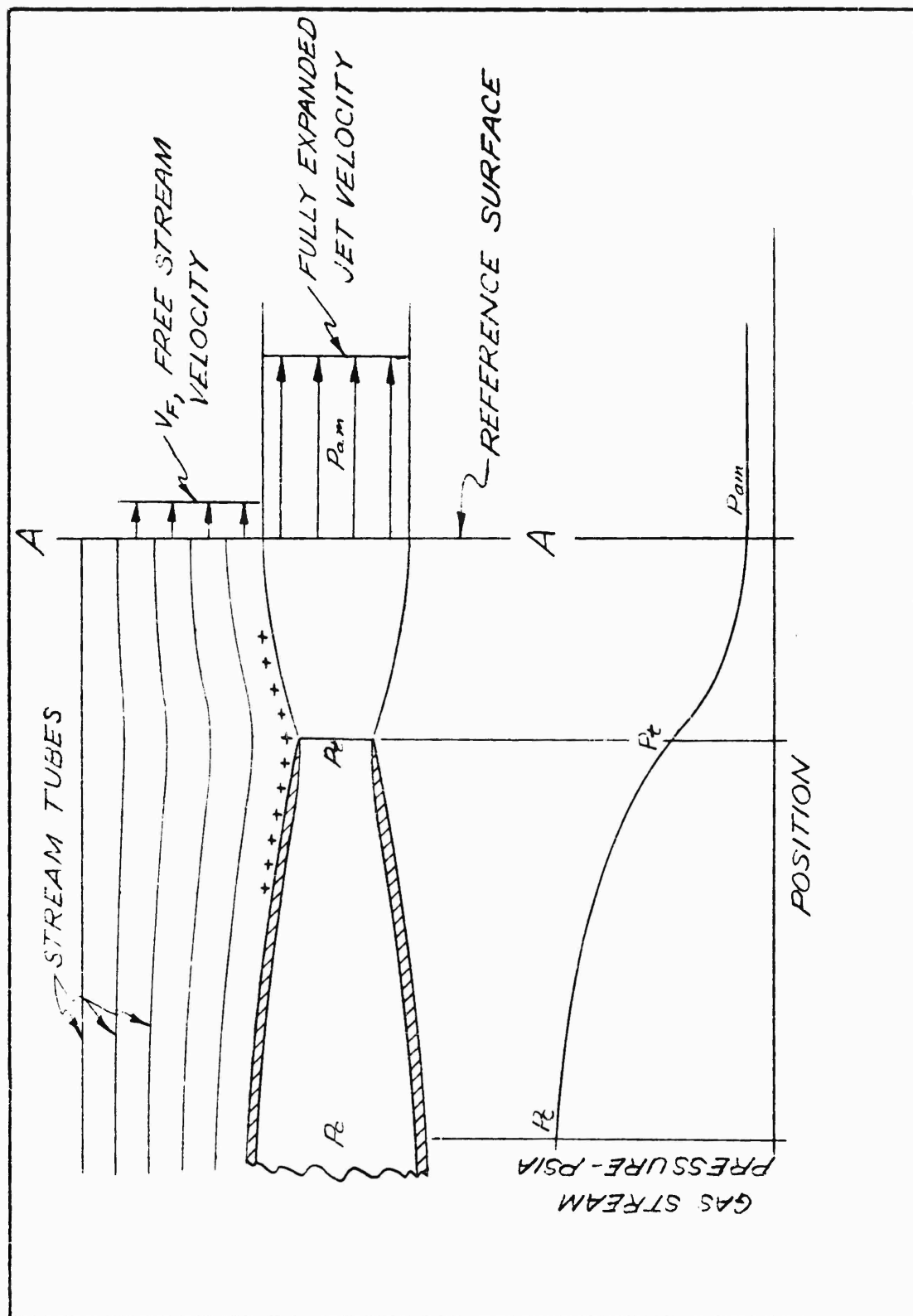
DRAG TEST
STEPPED MISSILE BODY

1. Stepped Body - Sucking Air
2. Stepped Body - Shut-Off
3. Smooth Body



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Figure 187



External Flow Confinement of Exhaust Jet Expanding from Critical Pressure

Figure 188



External Expansion of Hydroduct Exhaust from Critical-Pressure Nozzle